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German Practice with Tungsten-Carbide Tools

By Dr. George Schlesinger

Professor at the Technological Institute Charlottenburg, Berlin

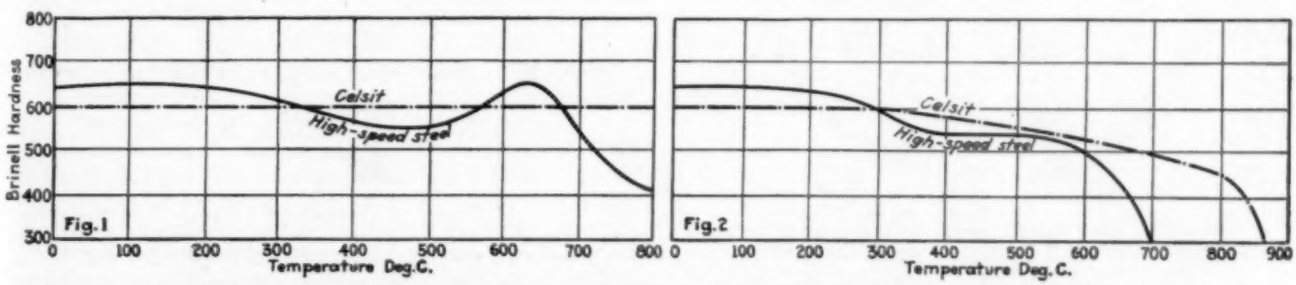
FROM 1900 to 1910, the forgeable high-speed steel reigned supreme in Germany. Its action was based mainly on the addition of 13 to 20 per cent of tungsten. It was followed by the American Stellites whose essential components were tungsten, chromium, cobalt, molybdenum, and carbon. Since 1922, however, the cast, non-forgeable alloys have been largely replaced in Germany by the tungsten carbides, which are not true alloys either, but consist of elements in powder form which are cintered at high temperature, and subsequently compressed under high pressure. This process results, of course, in an amorphous structure.

The inherent qualities of the tungsten-carbides, tool shapes, grinding, and cutting speeds are some of the points discussed. The effect on machine design, according to the author, centers chiefly in the provision of better bearings in the machines

In spite of their considerably higher cutting capacity, the cobalt-chromium-tungsten alloys have important drawbacks as compared with high-speed steels, since they are brittle and porous in consequence of their structure as castings. These drawbacks lead to damage of the cutting edge in cases where the metal is subject to shock, for example when the surface is interrupted by grooves, or the like. The German tool manufacturers, therefore, made an effort to overcome the defects of the American material. Akrit, Caedit, Volumit, Lohmanit, Celsit, and similar German alloys were at one time superior to the American alloys, but at present may be said to be on the same level.

The full utilization of the super-hard cutting metals requires machine tools whose driving power is considerably higher than that of the machines used up to the present, simply because the former are run at much higher speeds. They do not need to be built more strongly, as the forces required for taking off the chip have not increased, but have rather decreased. The fact that the majority of the machine tools, as now found in the shop, cannot be run at higher speeds than those used for high-speed steel, constitutes a serious obstacle against the early introduction of tools made of the super-hard metals.

The metals in cast form are more expensive than the high-speed steels, and the metals of the cintered tungsten-carbide group are three times as expensive as the Stellites. In order to cut down the cost, tools of all kinds



Figs. 1 and 2—Relation between hardness and temperature for the cutting tool metal "Celsit" and for hardened high-speed steel. Fig. 1 shows the hardness after the metal had cooled down from the test temperature, and Fig. 2 the hardness at the test temperature

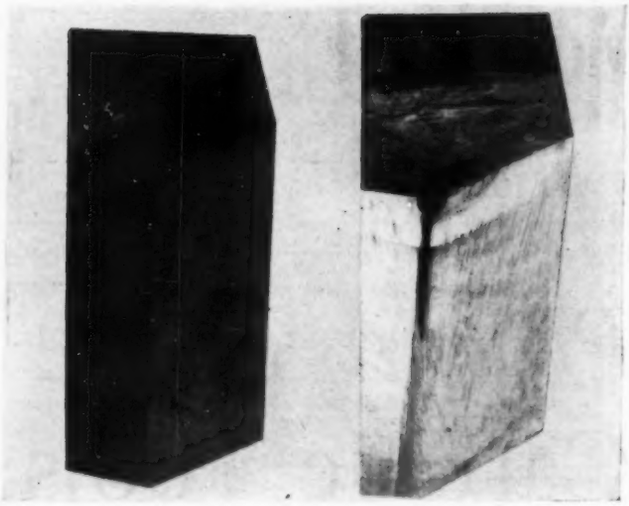


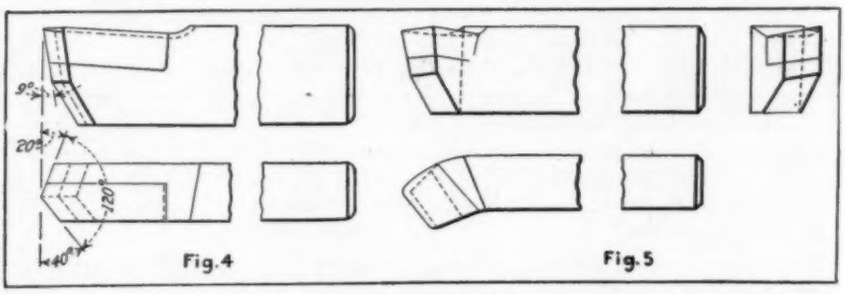
Fig. 3—Porosity in an early cast tool and the subsequent failure of such a cutting edge

Table II—Grinding Wheels for Cast Super-Hard Cutting Metals

Operation	Kind	Grain	Hardness	Coolant
Rough grind...	Silicon carbide	50–80	J-K (Carborundum grading)	Dry
Finish grind....	Silicon carbide	100–150	J-K	Dry
Precision grind.	Silicon carbide	180–200	H-J	Water

may be improved by letting hot liquid Stellite drip on the cutting edges, the amount required being thus reduced to a minimum. This method of application is suitable not only for lathe tools, but also for drills, milling cutters, gear hobbing and similar tools.

The superiority of the cobalt-chromium-tungsten alloys, as compared with high-speed steel, is explained by the fact that high-speed steel at 300 deg. (572 deg. F.) has lost 100 points of its original Brinell hardness, while at 600 deg. C. (1,112 deg. F.), it has lost 200 points. But the Stellites, for example, still retain their original hardness at 700 to 800 deg. C. (1,292 to 1,472 deg. F.), and even cut best when red hot, because the toughness of the tool material increases without decrease in hardness. The curves of Figs. 1 and 2 show the relation between hardness and temperature of Celsit (Böhler) as compared with hardened high-speed steel. High-speed steels fail when heated, even locally, by the cutting operation to temperatures above 600 deg. C. (1,112 deg. F.), whereas tools made of the super-hard metals withstand temperatures up to 800 deg. C. (1,472 deg. F.) without getting soft. Moreover, high-speed steel which has become soft by overheating, remains soft after it has cooled down, whereas the super-hard metals become hard again upon cooling. This explains why their cutting edges stand up longer. It will be noted that Celsit shows greater hardness at the highest temperatures for both the tests of Fig. 1 and those of Fig. 2.



Figs. 4 and 5—Straight and right-hand side roughing tools as ground when furnished with cutting tips of the cast metals

The cintered hard metals are considerably harder than high-speed steel, and can be tested only with a diamond cone. They have a still higher resistance to wear than the cobalt-chromium-tungsten alloys and do not lose their

Table I—Chemical Composition and Method of Manufacture of Various Super-Hard Metals

Name	Chemical Element C	W	Co	Cr	V	Mo	Ta	Ti	Cer	Fe	Manufacturing Process	Notes
Widia and Carboloy.	...	94+	6	...	...	...	..	..	..	....	Cintered products	+=tungsten monocarbide (about 6 per cent carbide)
Volomit.....	4	94	...	...	...	...	..	..	..	2	Cintered products	.....
Lohmanit.....	...	93+	...	...	...	7++	..	..	..	....	Cast products	+=tungsten carbide with 5 to 6 per cent C. ++=Molydbenum oxide
Miramant	2 (2 to 3)	55 (50 to 60)	...	...	...	20	15	..	..	....	Cast products	.....
Tizit.....	3	60	...	...	...	...	..	5	2+	30	Cast products	+=addition of cerium gives toughness
Celsit.....	2.8	25	31	26	0.6	...	..	.	..	4.6	Cast products	.....
Stellite.....	About 2	10 to 25	40 to 55	15 to 33	...	...	..	..	..	1.3 to 2	Cast products	Hutte, 25th. edition, Vol. 1, p. 804
Stellite.....	Up to 5	10 to 17	40 to 45	15 to 30	...	Instead of W	..	..	..	Up to 5	Cast products	Stahl and Eisen, 9125, p. 945
Stellite.....	...	12 to 20	40 to 55	25 to 35	...	...	..	..	..	Balance	Cast products	Rapatz, "Edelstahle", p. 166
Stellite.....	1.5 to 3	12 to 17	40 to 45	25 to 35	...	...	..	..	..	Balance	Cast products	Schallbroch, Aachen
Stellite.....	...	9.6	50.03	19.52	...	19.10	..	..	..	1.24	Cast products	Werksttats Tecknik, 1926, p. 96

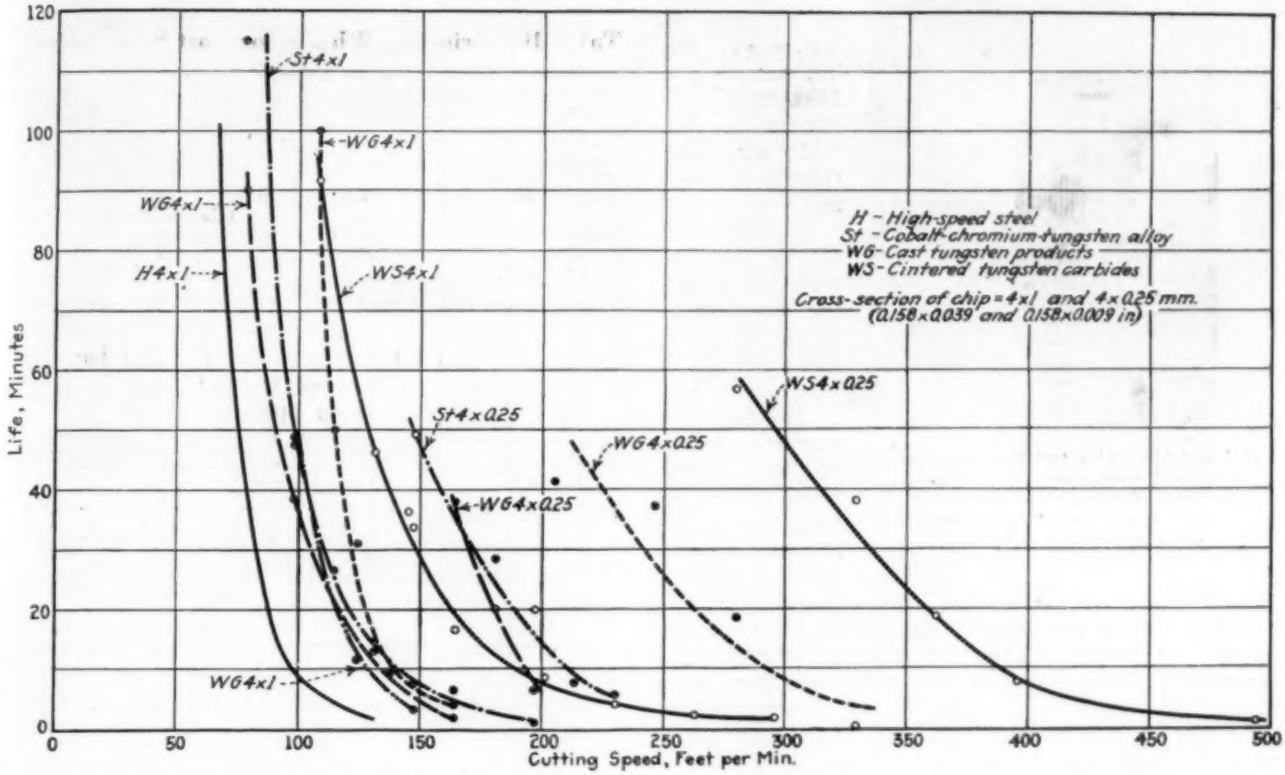


Fig. 6—Life curves of various cutting tools. Material: Siemens-Martin steel, 92,000 to 100,000 lb. per sq.in. tensile strength

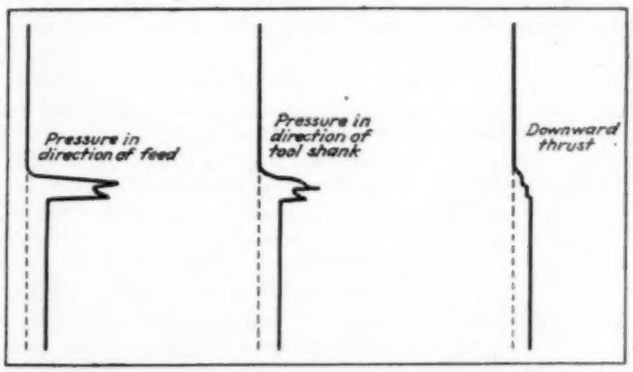


Fig. 7—Typical Schlesinger tool pressure diagrams for super-hard cutting tools during failure of the tool

hardness at all, within the practical range of work for which they are used. For this reason, they may be used for machining alloys which so far could only be ground. They may be used, for example, for turning 12 per cent manganese steel, and for machining steels which have been hardened. Even glass can be turned and drilled with tungsten carbides, at speeds varying from 10 to 15 meter (33 to 50 ft.) per minute. The feeds are small for tungsten carbides, while the cutting speeds are very high. Tungsten carbides give the best results when used without a coolant. In Table I the chemical composition and the method of manufacture of various super-hard metals are given.

Especially in the earlier development, the cast tools showed the defect that, under certain conditions, porosity was produced when the tools were not treated in a very careful and expert manner, such porosity leading to roughness of the cutting edge, and subsequently to its breakage. At present, however, so much progress has been made that cast cutting metals may be manufactured with great certainty of avoiding porosity. Fig 3 shows a porous spot and the effect in the failure of the tool.

A good example of a German cast super-hard cutting metal is the Röchling *Miramant*, whose melting point lies at about 2,200 deg. C. (3,992 deg. F.). Below the temperature of 1,500 deg. C. (2,732 deg. F.) the inner structure and the physical properties of this alloy are constant. Therefore, no softening is to be feared for temperatures below 1,500 deg. C. as the softening point lies as high as 2,000 deg. C. The compression

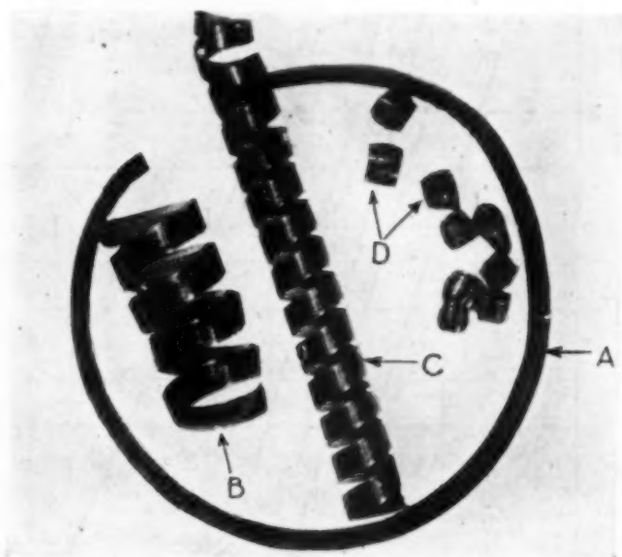


Fig. 8—Typical chips obtained during tests with tungsten-carbide tools. Chip A taken with a sharp edge on the tool; chip B when the edge is starting to wear away; chip C, when the edge has worn considerably; and chip D just before the tool fails

Fig. 9—This Widia tool has been automatically resharpened by "chipping action." Cutting speed 328 ft. per min.; chip 0.158x0.009 in.; cutting angle 38 deg. 18 minutes

strength of the alloy is about 80 kg. per sq. mm. (113,800 lbs. per sq.-in.). Miramant is not attacked by humid air and, therefore, does not rust.

A straight tool of this cast material, for roughing purposes is shown in Fig. 4, and a right-hand side tool in Fig. 5. The cast alloy possesses extraordinary hardness, but its toughness is low. A subsequent heat-treatment, like hardening and annealing, is superfluous with this material. It is not possible to change its shape by forging or rolling. The sharpening of the finished tools, both when they are new and when they have become dull, is performed exclusively by grinding, in the same way as with the Stellites. Grinding wheels of Carborundum or its equivalent, with a soft binder should be used. In order to obtain perfect and sharp cutting edges, it is necessary to give a rough grind with a coarse wheel, followed by a finishing grind with a finer wheel. The grinding speed amounts to 20 to 28 meters (65 to 92 ft.) per sec. The grinding process is performed preferably under light pressure, and usually dry. The grinding wheel must be well balanced and run without vibration. In Table II are listed grinding wheels suitable for different kinds of work.

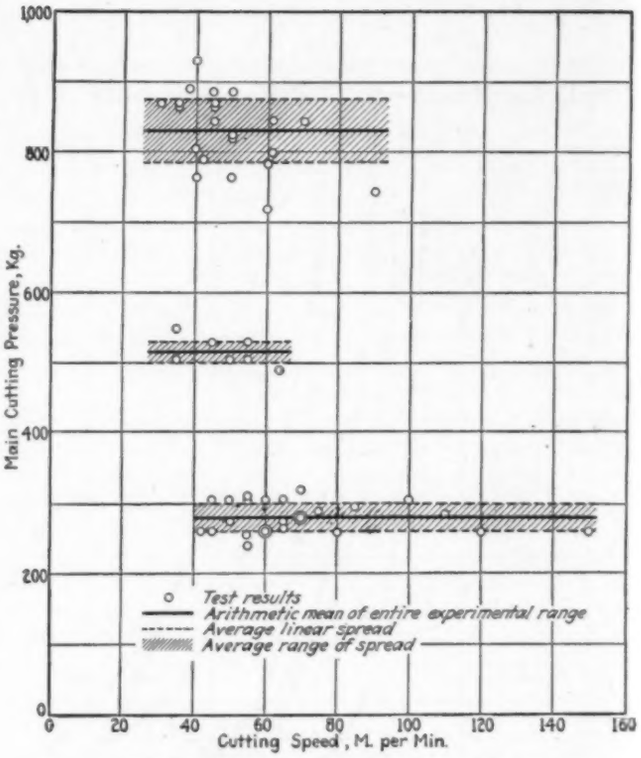


Fig. 11—Relation of the main cutting pressure and the cutting speed

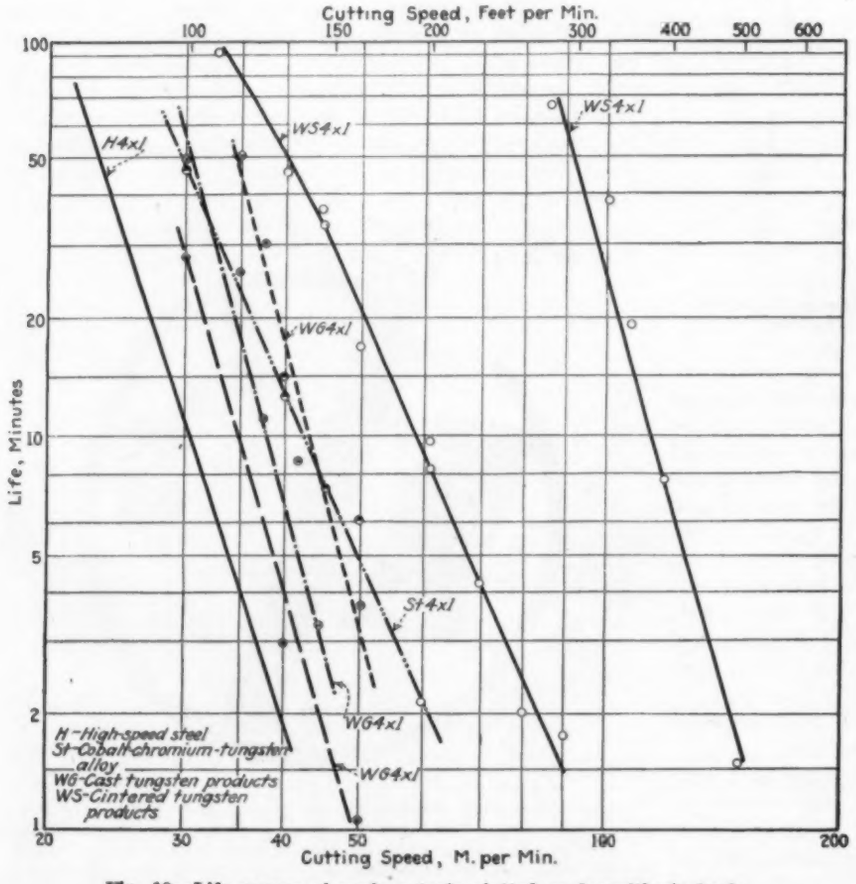
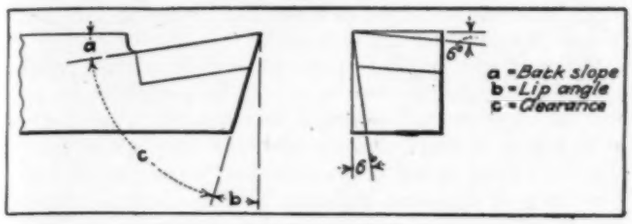


Fig. 10—Life curves of various tools plotted on logarithmic basis

The soldering of the cutting edges is performed with hard solder, or with pure copper. This soldering can be done best by mixing granular quick solder with burned water-free pulverized borax, the mixture being stirred with wood alcohol. The paste is applied to all spots of the tool shank, and the Miramant must be in contact with the latter. The small plate of Miramant is then tied to the tool shank with a string, and heated slowly and uniformly in charcoal until the solder has become fluid. The tool is then allowed to cool.

Among the tungsten carbides, the Widia alloy of Fried. Krupp, designated in the United States also by the name of "Carboloy," is one of the best. This material is available in bars with a square cross-section (6 to 20 mm.; 0.24 to 0.79 in.) in lengths up to 100 mm. (4 in.), and also in disk shape up to a diameter of about 32 mm. (1.26 in.) and a thickness of 13 mm. (0.51 in.). Plates of suitable shape are soldered to the tool shank with pure copper exclusively. The shanks must be rigid and tough; the best material for these being a nickel steel with a

Table III—Cutting Angles for Tungsten-Carbide Tools



Material to be Machined	Strength or Hardness	Back Slope Deg.	Clearance Deg.	Lip Angle Deg.
Nickel chromium and normalized steels	92,500 to 199,000 lb. per sq.in.	12 to 19	6 to 8	65 to 70
Mild steels	64,000 to 92,500 lb. per sq.in.	20 to 24	8 to 12	58
Cast irons with silicon up to 15 per cent	.....	2 to 7	3 to 5	80 to 84
12 to 14 per cent Mn steel	.....	12 to 14	6 to 8	70
Non-rusting steels	.....	14 to 24	6 to 8	60 to 68
Chilled cast iron	75 to 90 Scleroscope	2 to 4	2 to 4	82 to 86
Cast steel	71,000 to 142,000 lb. per sq.in.	8 to 24	6 to 8	60 to 75
Gray iron	150 to 400 Brinell	7 to 14	6 to 8	70 to 75
Brass and bronze	.....	7 to 12	8	70 to 75
Aluminum alloys	.....	16 to 22	8	60 to 65

medium carbon content. High-speed steel is not recommended as a shank material, because its use has led to difficulties in the soldering process.

Widia is also an alloy whose shape cannot be changed by heating; it can only be ground to the shape desired. The following grinding wheels may be recommended:

1. For the rough grind: Carborundum, or its equivalent, grain size 150, hardness E.

2. For the finish grind: Carborundum, grain size 163, hardness C.

These grinding wheels are very soft and must not be used for grinding the soft shank material, as they will become loaded. In order to avoid frequent dressing, it is recommended that the hard metal plates be ground in advance, while they are still in loose condition. Furthermore, care must be taken to grind first the front and then the back, as otherwise the cutting edge will be broken. Rounding of the point can be performed by hand, using a small grinding wheel. Abundant water cooling is a primary requirement.

Recommended Cutting Angles

For special materials which are difficult to machine, such as steel with 12 to 14 per cent manganese, bits and twist drills with Widia points are used. Drills entirely made of Widia are to be considered only for special materials, such as hard rubber, slate and paper. Widia differs from the cast metals in that it may be used for interrupted cuts, this being possible because of the toughness of the metal. In Table III are given cutting angles for tungsten-carbide tools which have given good results in practice.

In my experimental department for machine tools at the Technological Institute at Berlin, cutting experiments have been made with six different super-hard metals, as follows:

1. Cast metals:
   (a) American Stellite
   (b) Percit-Krupp
   (c) Walther hard metal, in the grades "hard" and "tough" (Walther Montanwerk, Tübingen).
2. Cintered metals:
   (a) Widia (Krupp, Essen)
   (b) Hard metal B (Siemens Schuckert Works).

All of these experiments were carried out on shafts made of Siemens-Martin steel, with a tensile strength of 65 to 70 kg. per sq.mm .(92,000 to 100,000 lb. per sq.in.), the Brinell hardness of which was about 192 kg. per sq.mm. When the experiments were started, the cross-section of the chip was 4x0.5 mm. (0.158x0.019 in.) and the cutting speed 100 meter (328 ft.) per min. With this high speed, no tool would stand up in machining the hard material of the experimental shafts. The speed had, therefore, to be reduced to 65 meters (215 ft.) per min. The main experiments were then carried out with the following cross-sections of the chip:

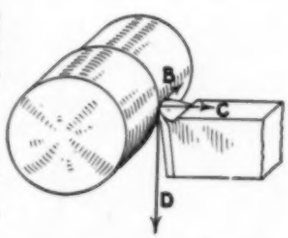
1. 4x1 mm. (0.158x0.039 in.) (normal cross-section)

Table IV—Cutting Pressures in Machining Siemens-Martin Steel with Tensile Strength of 92,000 to 100,000 lbs. per sq. in.

Tool	Test No.	Cutting Speed M. per Min.	Pressure B Kg.	Pressure C Kg.	Pressure D Kg.	Specific Cutting Pressure Kg. per sq. mm.
	37	50	174	350	825	206
	38	60	79	290	720	180
	39	60	154	345	785	196
A	40	40	136	335	805	201
	41	40	149	350	705	191
	43	45	157	375	865	216
	83	50	139	330	820	205
P	84	40	127	370	930	233
	91	30	152	380	870	218
	85	50	132	280	765	191
MWH	86	35	185	350	870	218
	87	42	122	285	790	198
	88	45	144	330	870	218
MWZ	89	38	131	290	890	223
	90	35	142	340	865	216
	65	90	37	195	745	186
W	67	612	62	215	800	200
	76	445	142	380	885	221
	68	612	147	315	845	211
HB	69	50	204	355	885	221
	70	70	139	325	845	211
	77	45	139	380	845	211
Average	..	...	141	339	831	208

NOTES: The B and C pressures in tests 65, and 67 to 70 have not been considered in calculating the average values because the tools used in these tests had only approximately the standard shape.

Summary of Results:
Feed pressure B = 141 ± 15 kg.
Shank pressure C = 339 ± 27 kg.
Main cutting pressure D = 831 ± 45 kg.
Specific cutting pressure = 208 ± 11 kg.



2. 3x0.75 mm. (0.118x0.029 in.)
(by way of proportional chip)
3. 4x0.25 mm. (0.158x0.009 in.)
(by way of chip with a small feed).

The cutting speeds varied within the range of 24 to 150 meters (79 to 492 ft.) per minute. In Fig. 6 the cutting speed has been plotted horizontally, and the tool-life vertically, the diagram thus giving comparative values for all of the tools when used for machining this particular kind of experimental material.

A comparison between the life of the super-hard metals and of high-speed steel, for the same cross-section of 4x1 m.m., shows that the best cintered tungsten carbides attain their most efficient working conditions at about 32 to 34 meters (105 to 112 ft.) per min., while the best high-speed steels attain this limit at about 20 meters (66 ft.) per min. The cutting speed of the tungsten-carbide cintered products reached a value two to three times that of the high-speed steels only when

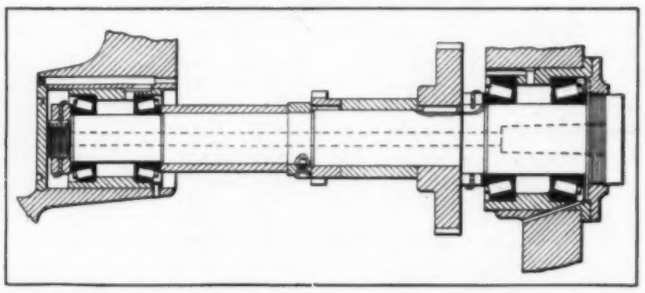


Fig. 12—One type of main-arbor construction which has proved satisfactory in Germany with tungsten-carbide tools cutting at two to three times present speeds. Basing his assumptions on the data given in this article, the author's opinion is that anti-friction bearings are the type most likely to be considered in future designs

the cross-sections of the chip were reduced, namely to 4x0.25 mm., and the life of the high-speed steel tool was not considerably increased by such reduction in cross-section of chip. While the tungsten carbides are considerably superior to the high-speed steels, the exaggerated claims made in praising the tungsten carbide tools should be taken with a certain reserve. It is necessary to know exactly what kind of experimental material was used and what cross-sections of chip were removed.

The life curves for the tungsten-carbide tools show the same character as those for high-speed steel (Fig. 6, *H* curve). The manner in which the tools lose their edge in consequence of the cutting pressure is also similar; in the majority of the experiments, there occurs a sudden increase in feed and shank pressures (as is shown by the Schlesinger criterion in Fig. 7).

Another remarkable phenomenon consisted in the tools repeatedly regaining their cutting edge by the chipping action. This became evident by the fact that the chips began to change from the short type (Fig. 8, *c* and *d*) to the longer type (Fig. 8, *b*). The tool continued to cut for a rather long time without any traceable influence being exerted on the feed pressure and on the back pressure in the shank direction. Fig. 9 shows a case where the keenness of the edges has been re-established in the manner described. In this way, it has happened that, although the cutting edge of the tool was expected to be destroyed in about 50 minutes, according to the normal life curve, the tools were used, for example, for 140 more minutes without losing their cutting capacity.

The pronounced rounded form of the portion of the life curves, forming the transition from the horizontal direction (short life) to the vertical (long life) is worth noting. There is no clear indication of the "infinite" life which would consist in a distinct change in the direction of the curve to the vertical.

Whereas the critical speed of the American cobalt-chromium-tungsten alloys seems to be greatly exceeded, for the experimental material in question, when a chip of 4x1 mm. is taken and the life is 60 minutes, a reduction in cutting speed of as little as 10 per cent is sufficient to give the very high life of 200 minutes. In the case of the cintered metals, on the contrary, a reduction of 10 per cent in cutting speed results in a life of only 85 minutes, less than 50 per cent increase. Therefore, it is not permissible, as has frequently been done, to start out from a life of 60 minutes and to estimate the cutting speed on the basis of the latter. The experiments must be continued until the cutting edge of the tool is exhausted, and we now have the means to do this.

If the life curves are transposed to a logarithmic system of co-ordinates, as in Fig. 10, their shape in the lower range approximates that of a straight line.

During all of the experiments, the cutting pressures were recorded. In Table IV the resulting cutting pressures are tabulated. The main cutting pressure in its relation to the cutting speed, is plotted in Fig. 11. It appears that, within the range of cutting speeds from 30 to 150 meters per minute, the main cutting pressure varies within the limits of the average spread. No influence of the cutting speed on the pressure could be detected. The cutting pressures, as a function of the cross-section of the chip, follow an exponential law. The following conclusions may be drawn from these tests:

1. The life curves of the super-hard metals have the same character as those of high-speed steel.
2. The chipping power of the cintered metals is more pronounced than that of the cast metals
3. The Schlesinger criterion for the loss of edge applies to the super-hard metals
4. In the logarithmic system of co-ordinates, the life curves can be closely approximated, in the lower range, by a straight line
5. For chip cross-sections between 1 and 4 sq.mm., the cutting speed as a function of the chip cross-section is a straight line, in a logarithmic system of co-ordinates
6. In the range of cutting speeds from 30 to 150 meters per minute, the cutting pressure is independent of the cutting speed
7. The Klopstock law for the cutting pressure:

$$P = 280\, F^{0.75}$$

is confirmed, for the material and the tools investigated.

The super-hard metals are to be considered in the first place for turning materials which cannot be machined economically with the best known modern high-speed steels, that is, materials with a strength of more than 80 kg. per sq.mm. (114,000 lb. per sq.in.) (up to 150 kg./sq.mm.). For lower speeds, but higher feeds and greater chip thickness, the high-speed steel is superior from a viewpoint of economy. The super-hard metals are particularly advantageous in cases where the cutting edge of the tool is subject to strong heating as a result of high frictional resistance. The fact that it has been possible to increase the toughness of tungsten carbides to such an extent that they are able to withstand severe shocks, opens bright prospects for these alloys.

Good Housekeeping in a Railroad Storeroom

By C. B. Lord
Associate Editor, American Machinist

A well-ordered storeroom requires few attendants and reduces the waiting time of the shop men

IN THE storerooms of the Carroll Park shops of the United Railways and Electric Company, of Baltimore, the time necessary to fill an order is reduced considerably by having the different materials classified and stored according to frequency of orders, and the quantity usually ordered. Material for which there is a frequent call is stored where it can be reached and delivered in the least possible time to the man asking for it. Heavy articles and those ordered in quantity are stored near the exit nearest to the department to which they will be sent.

A general view of the main floor of the storeroom is shown at Fig. 1. Each class of material is stored in a definite section, and its location is a matter of record in both the storeroom and the office. The sections are of different sizes dependent upon the classification of the material in them, and are divided into sub-sections that vary in width to accommodate either one or two rows of containers. In this way every container is placed on an aisle.

The different sections are distinguished by large signs or markers, and the sub-sections by the small floor markers shown in front of the containers. This small marker is used only where there are many small parts in a section and not as part of an arbitrary system. The dividing line between sections is indicated by painting the corner of the white strips black, as shown, between the third and fourth sub-section markers in Fig. 1. The aisle is also left wider between sections for trucking purposes.

The material is stored on the unit plan, which means that each container having similar parts contains the same

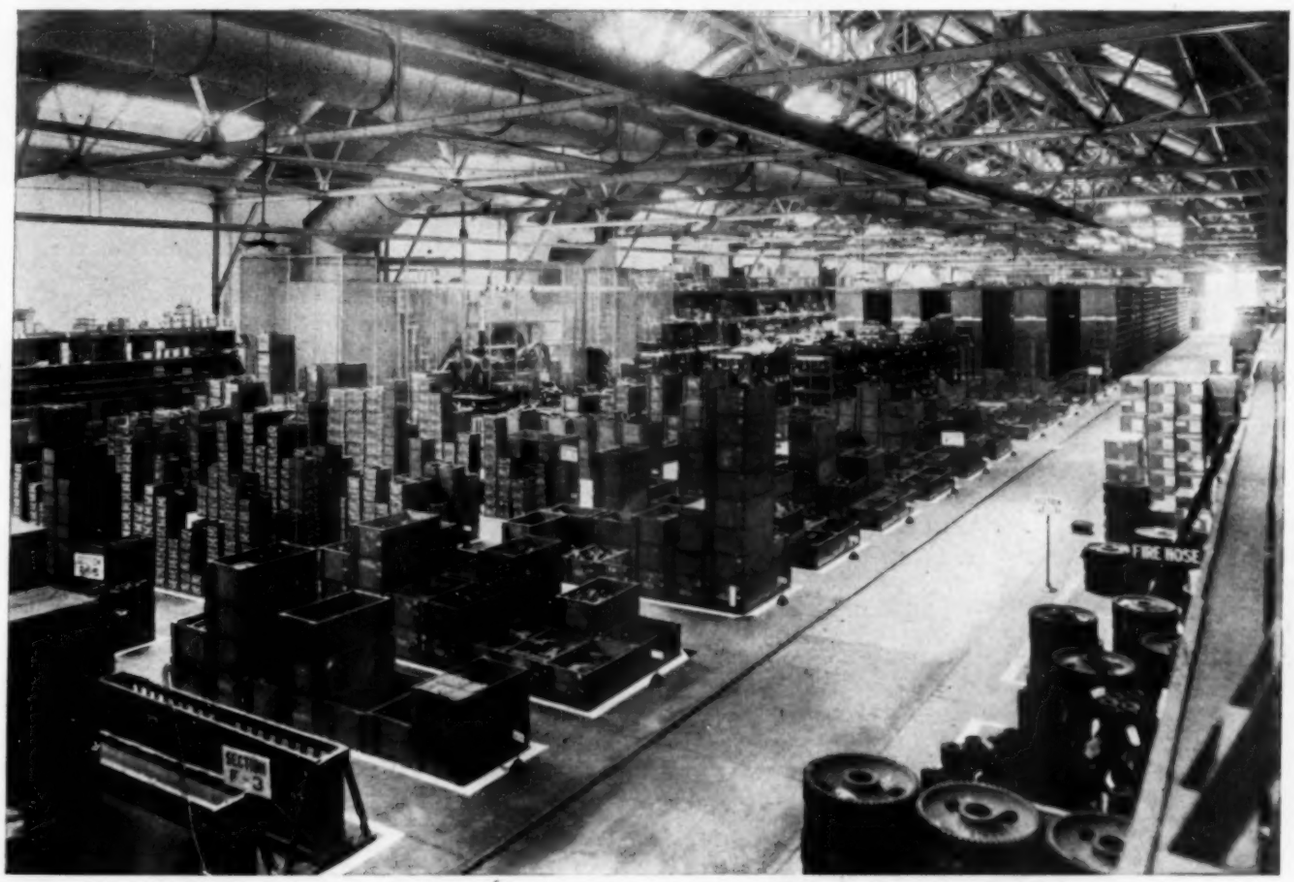


Fig. 1—General view of one aisle of the storeroom, showing the heating unit and the section and sub-section markers. The white lines limit the sections and sub-sections, and every container is on an aisle

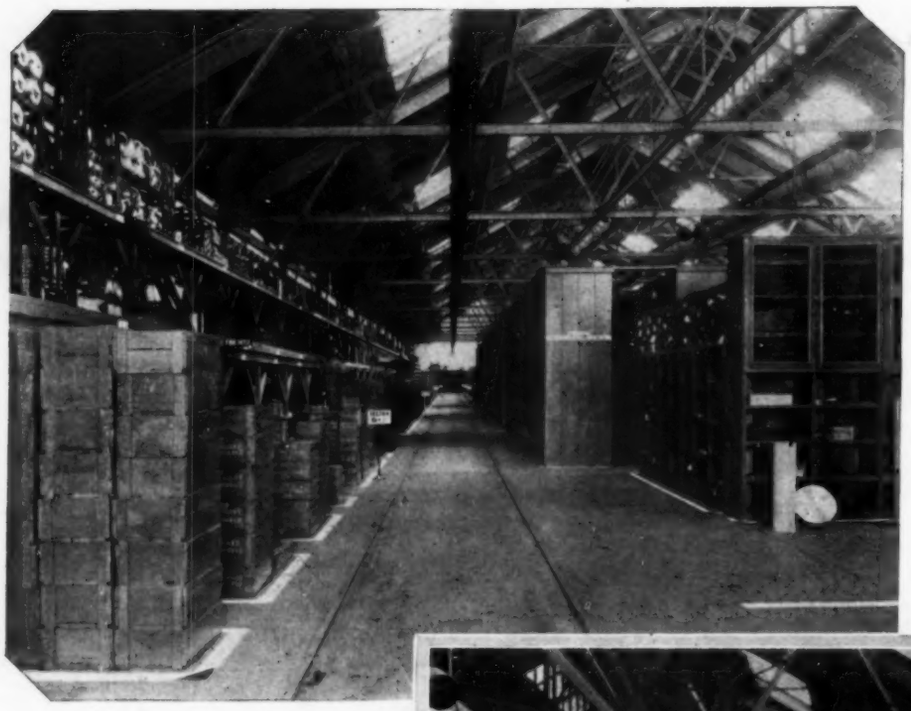


Fig. 2 — Aisle of storeroom showing the "set-back" galleries, and the pipe rack. Containers, each with the same quantity of similar parts, are shown on the left

Fig. 3 — Small parts storage is shown at the left, and material infrequently used at the right. An overhead trolley wire allows work cars to enter

Fig. 4—Oil room where each storage tank has its own measuring pump and drip pan. The drums shown on top of the tanks are being emptied

quantity. This quantity, together with the catalog, or order number, is chalked on the outside, neatly. A single unit is broken to supply small orders, and by using the plan it is possible to take a physical inventory of any article simply by counting the units and adding the parts in the single broken unit. By using chalk instead of paint, the boxes are available for any suitable material when empty, and a supply of specially indexed boxes is not necessary.

The office and storeroom co-operate in ordering and issuing stores. When a stores requisition is issued by the office, the section and sub-section where the article is stored is given, so that time is not wasted in looking up the location on a chart, or searching for the material physically. On the other hand, when the storeroom orders material, it makes out a purchase requisition and gives all the necessary information, which obviates duplication of work in the office.

The storeroom is warmed by hot air. The steam coil and circulating fan for this purpose are inclosed in the wire mesh section shown at the right, Fig. 1. The air pipes lead overhead with outlets at convenient points. In addition, the main pipes being uncovered, diffuse heat evenly throughout the room. This is considered an unusual refinement in a railroad storeroom, but its value has been demonstrated in this instance. Safety features are prominent, such as the location of a fire hose and extinguisher in good condition at every 50 or 60 feet.

In the side aisles, storage racks have been built to the eaves of the building. The two upper tiers have a "set-back" that gives room for a walk and space for a ladder. Views of this and the safety ladder arrangement are shown in Figs. 2 and 3. Some of the heavy material that is infrequently used is stored in the second tier of racks, and a tiering machine is used to elevate it.

Racks for pipe and steel are shown at the right in Fig. 2. It will be noted that the end of every pipe and rod is even with the edge of the rack and with each other. Various sizes of small rod and non-ferrous pipe are stored above. Screws, bolts and small fittings are stored in the racks shown at the left in Fig. 3, while at the right is stored wire, rattan for snow sweeper brooms, and similar parts that are called for but seldom.

In the oil house shown in Fig. 4, the floor is painted gray and is kept clean. Pans are used under each faucet in use, and no drip is permitted to strike the floor. Each storage tank has its own measuring pump and drip pan. Along the top of the tanks, and fastened to them, are rails upon which to roll the drums of oil for replenishing the supply in the tanks. The part to which the chain-block is attached is lowered to the floor, the chain-block is unhooked, and the drum rolled upon the carrier, which is then hoisted to the level of the tank top. The drum is emptied in the proper tank and left to drain.

Co-operation Between Drafting Room and Shop

By J. A. Potter

Chief Draftsman, Singer Manufacturing Company, Bridgeport Factory

THERE are so many sources from which difficulties can arise that it does not take much effort to imagine trouble in the ordinary course of manufacture, but to straighten it out in the shortest and most direct way is a different matter. Take for an example a case where certain milled parts do not come up to the gage, and yet in all succeeding operations the parts are found to be within the proper limits.

The drafting department is requested to check over the fixture, cutter and gage. Drawings are covered by a different checker and are found to be correct as originally made. Should that department then take the stand that as they are out of it the difficulty is up to the gage and tool departments?

If they are working for their day's pay, yes! If they are working for the company and incidentally their own best interests, decidedly no!

A manufacturing problem should be of just as much interest to the tool designer as the final assembly of a machine is to the machine designer. This does not mean that a drafting room should be equipped with surface plates, parallels, sine-bars, heighth gages and other measuring tools. It should mean that the drawing room is so situated that its supervisors can quickly determine what is wrong and take the necessary steps to get the work into production in the least possible time.

The first procedure would be to set up the tools and compare the cut with the gage. The difficulty can often be adjusted at this point, as it is often traceable to the improper use of tools, milling machine, cutter, or improper rake and clearance or backing off, if a formed cutter is used. The draftsman should be in contact with the shop on all of these points so as to avoid loss of time and unnecessary expense.

Immediate access of drawings and ease of handling should be considered as against taking out tools from the manufacturing tool crib. A glance at these drawings may show that the part could have sprung out of shape in a succeeding operation, that drop dies did not set the work enough or too much, that the part in question had not been located from the same surfaces throughout, or was located on the rough when the finished surface should have been used, and that the trimming die for drop forging did not match up. They might also show many other items that an experienced man would look for before giving snap judgment and condemning the tools which were apparently causing trouble.

A man does not have to be endowed with any particular amount of tact to follow out the above procedure, but it does put him in the position of being part of the shop where it is up to him to show or be shown. He will find that nothing is to be gained by stalling, that mistakes will out in the long run, and that his best policy will be to gain a reputation for getting out work. If this were the general attitude, would not the drafting room and the manufacturing departments work in closer harmony?

In deep-drawing operations the lubricant placed on the sheet metal warrants more attention than is ordinarily given by the press department. While machine oil is used extensively in many shops for this purpose, a good grade of lard oil, or lard oil mixed with graphite, will give results worth the extra cost.

EXECUTIVE · FORUM

Insuring Machines Against Undue Wear

"POOR lubrication," declared the oil salesman, Art Grayson, at the lunch club, "is responsible for seventy-five per cent of all your machine failures. You can cut out most of that by using good lubricants and the best lubricating systems."

"I've heard that seventy-five per cent stuff until I'm beginning to doubt it," spoke up Ed Farrel of the textile shop. I'll admit it's a lot more than it ought to be, but all kinds of machines are oiled much more thoroughly than they ever were before, and I know our percentage of oil failures is a lot lower than seventy-five."

"But most shop men don't realize how important proper lubrication is," continued the oil salesman. "If they did, you'd all be using our system of lubricating machines."

"Even allowing for your outburst of enthusiasm, I think that's putting it a bit strong," said Farrel. "I'm inclined to believe it's good, but why don't you give us some sort of guarantee as to what it will save us?"

"We'll save you money both in oil and in wear and tear. I don't just see how we can guarantee any special amount. That depends as much on how you use it as it does on the lubricating system itself."

"I've been thinking," said Farrel, "that if you lubrication birds really believed what you said you'd give us some sort of an insurance policy if we installed your system—Sort of guarantee us against undue depreciation over a period if we used your oiling system."

"What's the use of kidding him, Ed," spoke up Ben Brewster. "You know they couldn't."

"I'm not so sure, Ben. If a company can earn scads of cash by insuring boilers against explosion why can't these oiling fellows insure machines against excessive wear?"

"But we don't know how you'll use the machines when we are not around," protested Art.

"Neither does the insurance company know how boilers are used when their men are not there, but they insure them just the same. Your men could inspect the plants at any time, and see that the lubricating devices were on the job. You could figure this inspection cost in your insurance premium just as the boiler insurance company does. If you come to us with some such scheme as that, we'd be interested."

"Just how could they do that, Ed?" asked Brewster.

"I haven't worked out any details of course," said Ed, "and I wouldn't expect insurance against normal wear. That's why I said 'undue wear' to distinguish from the wear that is inevitable. And by wear I mean the breakdowns that stop production, and that our oil friend says are due to poor lubrication.

"They can insure us against breakdown due to dry bearings and against wear or depreciation of say more than ten per cent a year. If a machine equipped with their system breaks down from bearing troubles or requires more than normal maintenance charges to keep it going, they pay the bill. Seems very simple to me when you think that Lloyd's will insure you against bad weather or almost anything you can mention. Of course the rates are high for such freak insurances, but if, as our friend says, his oiling system will prevent most of our machine troubles, why can't his company back it up with insurance?"

"Ever hear anything as wild as that, Mr. Holland?" said Brewster to Bill Holland, who is a good listener at times.

"There's a good friend of mine out in the Middle West who has been playing with some such idea for several years. He wants to insure his machines so that they will be replaced by the insurance company when they reach the point where they are no longer good enough for his plant, even though they might be O. K. in some job or contract shop. He even wants to figure in an obsolescence factor in some cases. It may sound a bit wild, Ben, but it may be fairly tame, after all."

Executives are invited to discuss the problem involved in the foregoing case. They are also urged to use this department to air their own problems. A letter to the Executive Forum Editor is all that is needed.

DISCUSSION

Hiring Men From Other Shops

The indiscriminate hiring of men away from other shops is a bad practice, which in the long run benefits no one in particular, and does a lot of harm both to the organizations and the individuals involved. However, where there is an opportunity for an individual, definitely greater than he has in his present concern, there should be no restrictions keeping opportunity and individual apart. Executives should encourage their employees to have confidence in them, so that when a man receives a supposedly better offer he will come into the office and frankly discuss the situation. If the new offer is a real opportunity, the employee should be released with a good-luck send-off, while, if it is shady, and appears to have hidden strings attached to it, the undesirable features should be frankly pointed out. Fair play will earn the confidence of the men.

Agreements between firms in a certain locality, regarding the hiring of men from other shops, do not particularly help the situation. Those who feel inclined to break the agreements will find an excuse, or way, to get around them. In the absence of the agreement each situation can be met in a spirit of fair play and co-operation between the men and the shop.

— JOHN F. HARDECKER, *Chief Draftsman, Naval Aircraft Factory, Philadelphia.*

Reducing the Scrap Heap

Training workers in the general principles of a trade, or job, is certain to reduce the scrap heap. Inexperienced workers are continually applying for employment on tasks which require experience. Frequently these applicants are rejected by the employment department, but often they must be hired and tried because of the necessity for workers. Often workers, who are generally skilled in the trade, must be trained in the particular branch of the work, if spoiled parts, machine breakdowns and accidents are to be reduced to a minimum.

While for industry as a whole the days of apprenticeship appear to be past, competent workers are required on all production jobs. Knowledge of materials, machines and processes has become more important as knowledge of tools and handicraft has become less important.

In some cases, workers must be trained while engaged in the regular processes of production. It is essential that such work be checked up continually to make sure that the training is properly carried on. Training under the immediate supervision of the foremen is an ideal method, because under modern industrial methods foremen have been relieved of many of their previous duties, and are left free for supervision and training. All foremen are not inherently successful teachers, but, if they have a complete knowledge of their work, they may themselves be readily trained to impart this knowledge to others.

Foremen are often aided in the instruction of beginners by an assistant particularly designated for that work, in the case of large departments, or by workmen in smaller departments. Workmen, of course, must be specially rewarded for giving such instruction. Training under the foremen will be successful if foremen understand that this is one of their chief duties, and if means are provided for following up workers to see that they are receiving adequate training. The entire training program represents a good investment, because skillful and efficient workers mean a reduction in spoiled work.

—HARRY KAUFMAN, *Public Accountant.*

Rewards for Suggestions

The one fundamental difficulty about every suggestion system is the apparent impossibility of determining the true worth of any new idea before it has been tried out. If a firm puts up a five-dollar prize it will get a great many two-dollar suggestions, a few four-dollar ones, and, once in a blue moon, a ten-dollar one. As a gamble it is a losing one. A suggestion that is worth only five dollars is no suggestion at all. A suggestion that will save or gain for the firm a thousand dollars a year for five, ten or twenty years is very much worthwhile, but the man who drops it in a suggestion box that has a five-dollar label does not deserve even the five dollars. He should be given a ticket to the nearest hospital for the weak-minded.

Every employer has men, and foremen, too, whom he suspects of holding out ideas on him. For once employers are right. The way to get a holdout to sign on the dotted line is to make the inducement worthwhile.

Since no one knows what an idea is worth until it has been put to work, why not put it to work and share the gain with the man that invented it? Why not offer the man a share in the net profits from the use of the idea even if it not patentable? To be sure, there are men who would rather have ten dollars today than hope of a hundred a year for life, on the score that they may not live to get the first hundred, but there are plenty of others who will say to themselves, "If I can get a hundred a year for a hundred suggestions, why not?" —ENTROPY.

Net Results—Not First Cost

The purchase of cheap equipment proves more expensive in the long run than if a high-grade article had been procured in the first place. Cheap tools will not "stand the gaff," and when the cost figures are totaled at the end of the year they will be found higher than if the job were carried through with first-class equipment. With this thought in mind we devised and have operated the following system:

In starting, we organized what we called the "Tool Ordering and Follow-up Department,"

whose business was to procure the best type of tools available, and to follow up the operation of each tool, and record its performance against our standard records. With the department well under way, we proceeded to make contact with many of the tool manufacturers of the country, requesting them to send us their standard catalogs, together with all available data. When these pamphlets arrived, we filed and indexed them according to the various types of tools. We then listed what we considered to be the ten best tools of each kind, such as standard lathe tools, milling cutters, gear cutters, boring tools, drills, reamers, and other types. We purchased these tools and graded them out, until we had picked out three of each type, which were considered most suitable for the work in hand. The best of these three we stocked as standard tools, recording the other two as substitutes.

When grading these tools we compared them for price, durability, number of pieces machined before regrinding, cutting speed allowable for best performance, and tool workmanship. Steels which showed cold shuts or mechanical flaws were rejected, and if too many came from the same company, that concern's record card was placed in the unsatisfactory file.

We found that by purchasing high-class tools and standardizing them, it was possible to maintain a smaller tool crib in each department, our production was increased as much as 40 per cent, our labor turnover was proportionately less because the men were earning a higher bonus with good tools on the job, our scrap pile decreased considerably, because our mechanics were becoming highly skilled by remaining on the job for longer periods of time, and the most surprising fact was that our machine maintenance was cut in half, This was due chiefly to the fact that when dull tools are used there is a severe strain on the machine, but where sharp tools are used continually, the strain is decreased, and the life of the machine is increased.

—Fred A. Schmidt, *Industrial Engineer, Western Electric Company.*

Getting Men From Other Industries

Wide experience is of great benefit to a superintendent. Too often, by staying in one line of work, a man becomes bound to the traditions of that particular kind of manufacturing. He is prone to play safe by sticking to the same old methods, and rarely takes the chances required to improve the quality and quantity of production and reduce costs. This attitude is fatal to success and progress. With such a narrow viewpoint, few men in executive positions would be able to assist in keeping their industries in step with modern developments and on a profit-paying basis.

When a man is brought in from a different line of work, he introduces a fresh viewpoint. The shop and work are new to him, and in order to become thoroughly familiar with operations he must inquire into the whys and wherefores of each job, and take nothing for granted. Since he does not know much about the details of the work, he does not take the attitude that it cannot be done in any other way. On the contrary, he is willing and eager to try innovations which promise good results. This constant striving for better methods, in the end, will meet with success, and will show up in the ability to pay better dividends.

—L. O. Brown, *Tool Room Foreman, Holcomb & Hoke Manufacturing Company.*

Discouraging Rush Orders

It is a good plan to leave a place in the production schedule for rush orders. The general run of orders in most industries need have no specific shipping dates. Two or three weeks usually means on, or about, a certain date. If on the acknowledgment copy of the order the customer is promised a shipping date falling two or three weeks in advance, this indefinite date will leave room for rush orders. If too many rush orders come in, the dates specified on acknowledgments can be further extended to allow for the rush work.

When regular customers wish earlier shipping dates, they will write in to say so. For these customers the delivery periods can be shortened, because room has been left on the production schedule for such contingencies. Any temporary production jam can be relieved by overtime, by setting back another order, if the customer agrees, or by transfer of men between departments.

The chronic "wolf crier" can be handled through the sales force, or by the manufacturer's representative. It may not be possible to have the customer remove the objectionable "rush" from his order, but these representatives can ascertain the urgency of orders and get a reasonable shipping date accepted. Once fixed, shipping dates should be lived up to religiously, so that customers will learn that the company keeps its promises.

When an order is labeled "urgent" it is well to ask the customer frankly how urgent the need is. In a recent case, one of our customers wired to us on a Saturday morning an order labeled "rush-urgent-breakdown." We wired back, "Is Monday all right or shall we do overtime." The customer agreed to the Monday shipment. Two weeks later a letter came in stating that the size ordered was in error, and that we should send another size. This concern is one of our good customers, and we shall be very glad to oblige them again on a rush order. Quick delivery strengthens the goodwill between companies. But the next time this customer will probably give a rush order more thought, and allow us all the time possible.

Someone may say that our company is engaged in the manufacture of only a few standard items. This, however, is wrong. We make semi-special equipment, about 95 per cent of which is assembled from standard, stocked parts, only on customer's order. —J. Paton.

Porcelain Enameling Metal Parts

By P. W. Hopkins
Geo. D. Roper Corporation

PORCELAIN enamel is simply ground glass fused upon steel or cast iron. Its surface is very similar to china in appearance, and it must be handled in much the same manner.

At the plant of the Geo. D. Roper Corporation the materials that are used in making enamel are stored on a balcony which extends over a portion of the shop. Under the balcony is the mill room, shown in Fig. 1, in which the different kinds of enamel are mixed. The glass, chemicals, and other ingredients are fed through hoppers on the balcony floor into several tumbling mills. In these mills, the ingredients are ground until they are smooth and of a paint-like consistency. The mixture is then forced out of the mill by means of air pressure, into storage vats, also on the balcony, and allowed to age for about a week. By that time it is ready for use.

The various coats of enamel—except the ground coat—are applied to the metal by a spray gun, using an air pressure of 80 lb. per sq.in. The supply of enamel for each spray is supplied from above, in small quantities. This is accomplished by locating the individual spray booths under the balcony, along which a man travels and supplies the liquid enamel to individual open containers connected to the spray gun at each of the booths. By this means the enamel is maintained at a uniform consistency and delivered to the gun at a constant pressure, and without stopping the operation.

Sheet-metal and cast-iron parts that are to be enameled are received at the stockroom, and are distributed from there; the sheet metal goes to one department, and the cast iron to another, where they go through the particular cleaning operations in preparation for the application of the enamel.

The sheet-metal parts are loaded into steel racks or baskets as shown in Fig. 2, and are placed on a roller conveyor that leads to the dipping room, where they are passed through the various solutions necessary to clean the surface thoroughly. After the cleaning operations the baskets containing the parts are placed in the drying oven shown at the end of the room, which is heated to 150 deg. F., by waste heat from the enameling furnaces. The reason for immediate drying is to remove all moisture quickly, and eliminate any possibility of oxide forming, which would make it impossible to enamel.

When the parts are dry they are again placed on a roller conveyor and proceed by gravity to the enamel dipping room shown in Fig. 3, where an operator removes them from the basket, dips them in enamel and hangs them on an endless chain conveyor which carries them through another oven in which the water is evaporated from the enamel. On the return trip the conveyor is washed thoroughly to free it

> Cast-iron parts that are to be porcelain enameled are sand-blasted and stored in heated storerooms, while sheet-metal parts are chemically cleaned

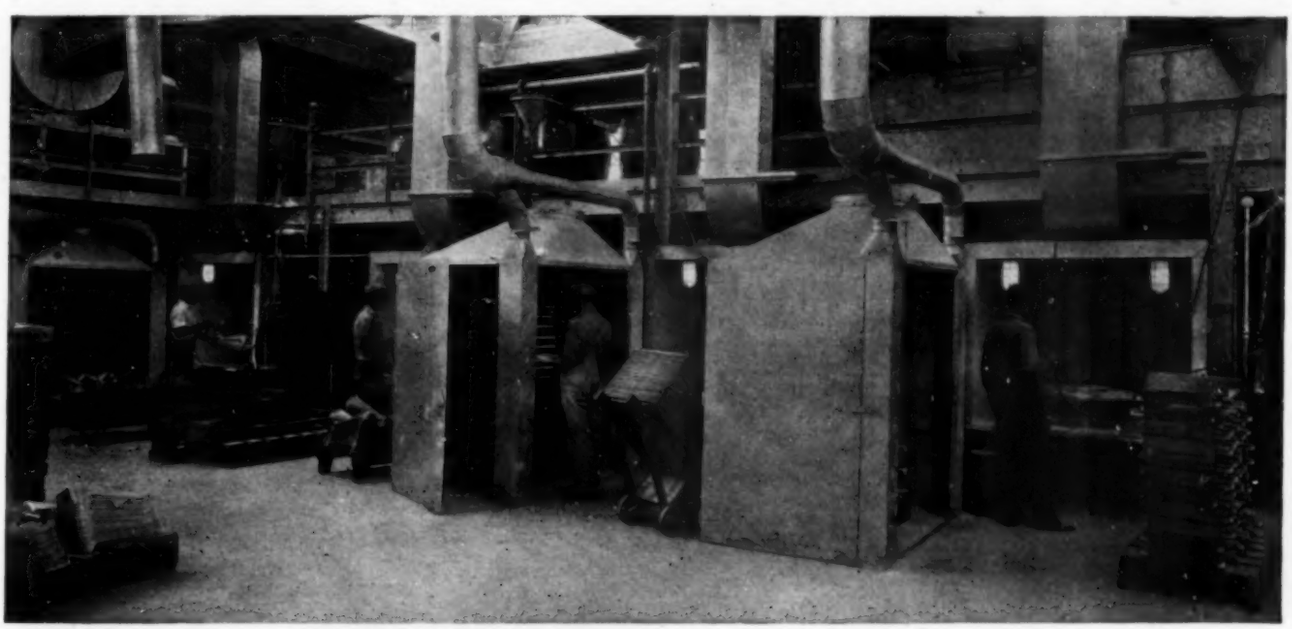


Fig. 1—The first coat is sprayed on cast-iron parts, while it is put on sheet metal parts by dipping. The parts are placed in drying ovens immediately to drive out the moisture, which might form oxide and discolor the enamel

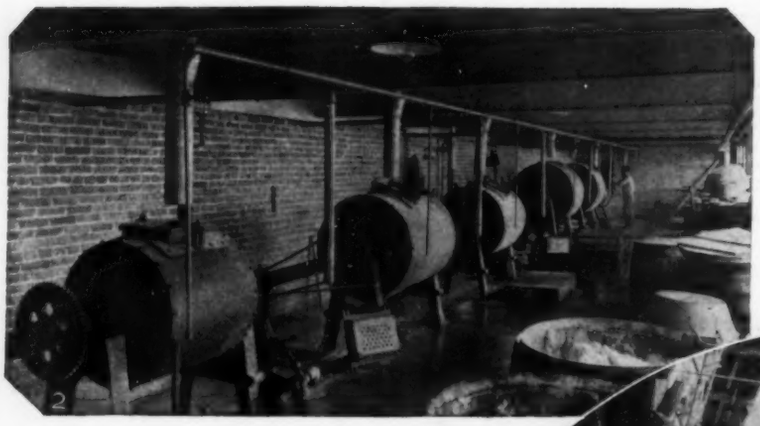


Fig. 2—The ingredients are fed to the mixing drums by gravity. When thoroughly mixed the enamel is forced to elevated storage tanks by compressed air

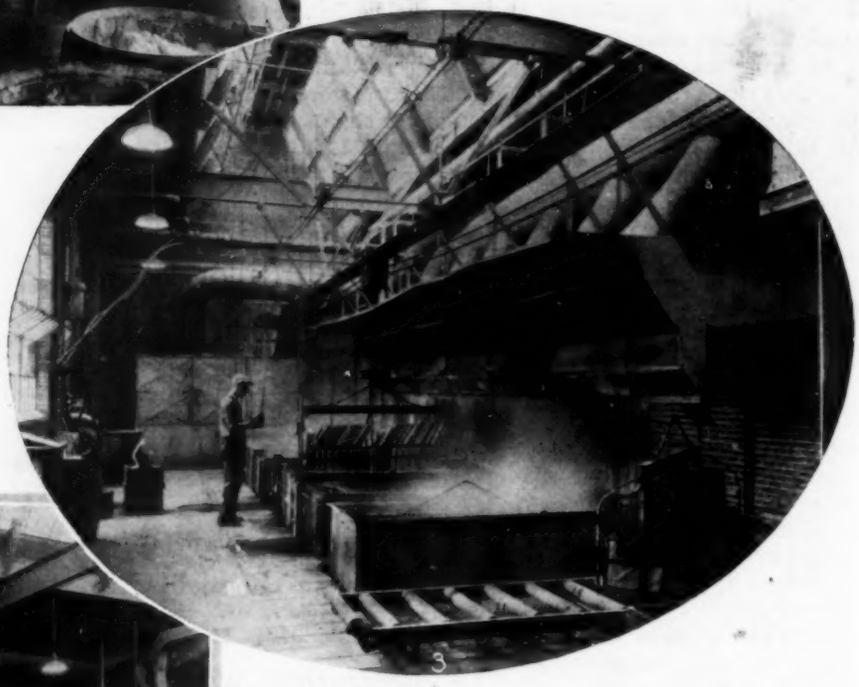


Fig. 3—The preparation of the surface plays an important part in enameling. Steel parts are cleaned by dipping, and are dried immediately to prevent oxide from forming

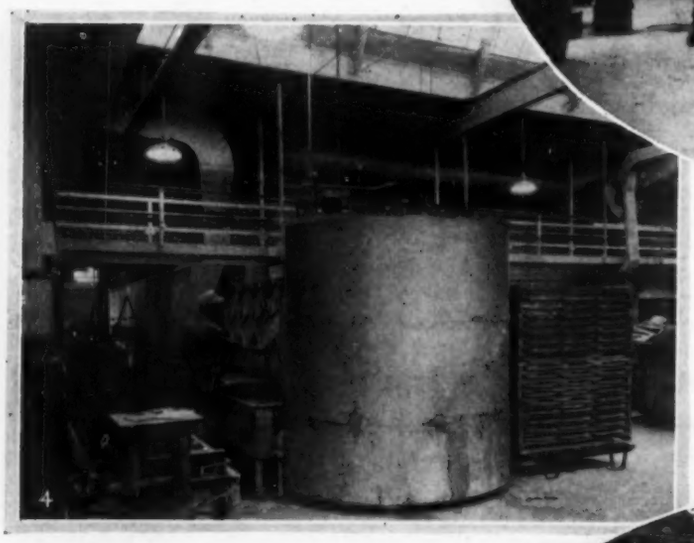


Fig. 4—After the first drying, the steel parts are dipped in enamel and conveyed through drying ovens heated to 150 deg. F., on endless chain conveyors to drive off the moisture

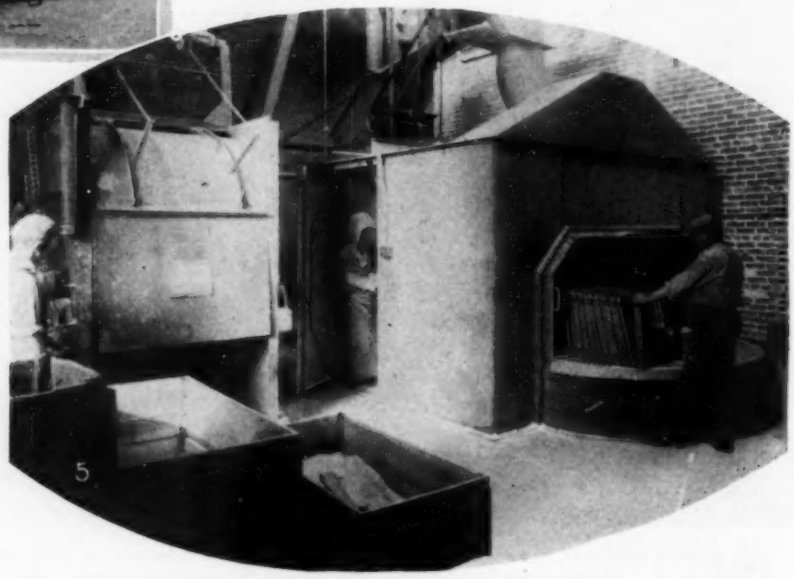


Fig. 5 —Cast-iron parts are sand-blasted and stored in a heated room. The castings are fed into the blast chamber on a revolving table

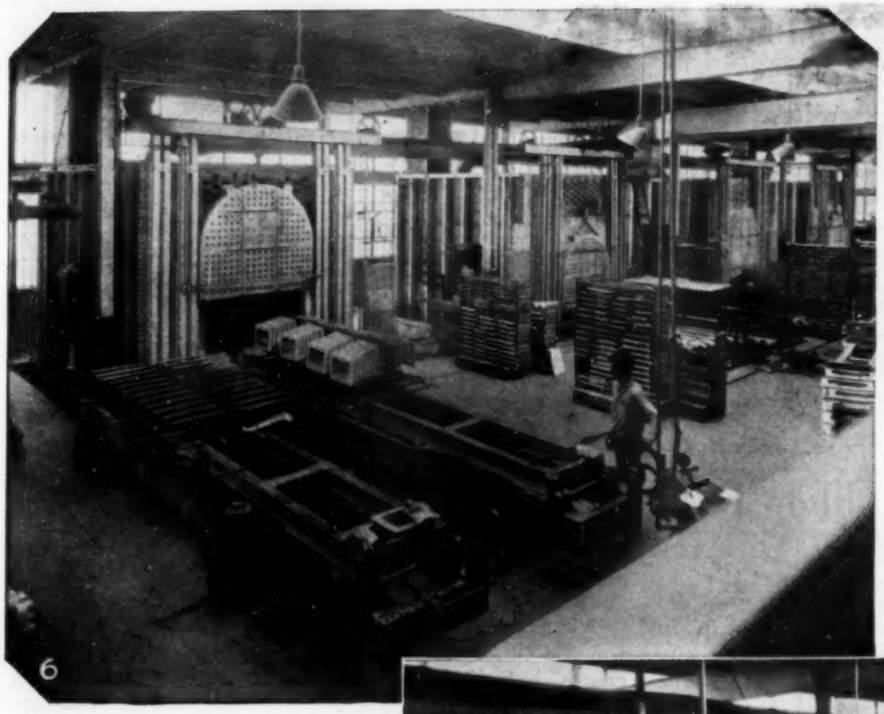


Fig. 6—The furnaces are gas fired. The temperature is controlled by regulating thermostats, and is recorded by pyrometers. Each furnace is served by two pneumatic charging cars so that the furnace may be immediately recharged while the load removed from the furnace is cooled before being moved. The temperature used for fusing the enamel on sheet metal is higher than for cast iron

Fig. 7 — Cast-iron parts are sprayed separately from sheet-metal parts. Men are employed for spraying cast iron, and girls for the latter. The conical enamel containers are fastened to the rail of the suspended platform, along which a man walks to keep them supplied. This method assures a uniform consistency and constant pressure on the enamel

ware is then rolled in front of the furnace, and charges it, so that little time is lost between unloading and charging. The handling of the loading carriages is by means of compressed air.

After the enamelware taken from the furnace has cooled sufficiently, it is inspected and sent to the spray room, where a coat of black enamel is applied. After this operation the parts are again placed on racks and delivered to the storage place in front of the furnaces, where they are allowed to air-dry until their turn arrives for going into the furnace again. The second "burning" is at a temperature of 1,500 deg. F., after which the parts go back to the spray room and receive a third coat of either white or pearl gray enamel. This coat is also air-dried for several hours, after which the part is taken to the brushing room.

This brushing operation is simply wiping off the white, or gray, enamel at places which are going to fit closely against another part when the different parts are assembled. Black enamel is used on contact surfaces because it is much more durable than white or any of the colors, and, hence, less likely to chip when assembled. The brushing operation leaves an attractive black edging around a glistening white body coat.

After the brushing operation the enamelware is again taken to the furnace and burned, and then returned to the spray booth room for another, and final, coat of white enamel. The same routine of spraying, drying, brushing and burning is followed. After the final burning operation each part receives another inspection, and is then sent to finish stores until needed for use.

The treatment given cast-iron parts is somewhat dif-

ferent: Instead of being chemically cleaned, they are sand-blasted and are stored in a hot room immediately to prevent them condensing moisture.

From the hot storage the castings are taken to the spray room as needed, and are given a sprayed coat of white enamel instead of being dipped, as are the sheet-metal parts. The separate spray room for cast iron is shown in Fig. 5, and it will be noticed that each operator has an individual booth with a drying oven at one side into which the sprayed parts are placed immediately. A temperature of 150 deg. F. is maintained inside the drying compartment, which seals the surface and dries the enamel quickly, thus preventing rust discolorations appearing later. Cast iron is burned at a temperature of 1,300 deg. F. instead of 1,600 deg. F., as with steel. After the final burning the parts are inspected, wrapped in cloth bags and packed in boxes for delivery to the stock room where they are stored until needed in the assembly plant.

Among the difficulties encountered in enameling are: Blistering of the porcelain surface, flaking off, discoloration, checking, and the enamel being too brittle to withstand the handling which it must encounter. To produce the best quality of enamel, the proper kind of metal must be used, and the preparation of the surface must be given close attention. The enamel must have the same co-efficient of expansion as the metal to which it is to be applied, it must be of the proper consistency when applied, and the burning must be for a definite length of time at an even temperature.

The Small-Shop Foreman As Personnel Man

By Arthur Mumper

MANY factors which should and do enter into the average shop foreman's production problem in a modern shop are entirely overlooked by too many executives—factors and conditions which affect the quality and output of the shop to a great extent, but which receive little consideration from the management.

While the tendency in the majority of the big shops is toward recognizing the employees as human beings with ambition for the better things of life, with desires for a higher social standing and better education for their children, the managers of many of the smaller shops still cling to the idea that a machinist is a man of a low order with hands that are skilled in what they are to do, but without any functioning of the brain.

This brings me to the statement that personnel is the foreman's biggest problem. His greatest aid to production lies in developing a proper mental attitude on the part of the men toward their work and the company and toward those who are in charge of the management of the plant. The foreman's job becomes much more difficult when the management shows by their dealings with the men that they have little or no consideration for them. It is necessary for him to receive the complaints of both the men and the management and to so refine them that there can be no harsh feelings on either side.

Unless a man's mind is free from thoughts that he is not getting a square deal from a company, that he is working toward a certain end that the management will not recognize, and unless his mind is free from worries, he is not mentally able to give the company his best efforts, and unless he can give his best efforts, the management is not satisfied with him. As an example showing just how this works, I want to cite a case with which I was much concerned recently.

It had become necessary for me to break in a new operator on a certain machine. I picked for this job a young man who was a good man on certain kinds of work. I felt he would fit into the new job just right but he was not very popular with the manager. Why this was so I could never decide, for he kept at his job, did close work and his time on any job he did was good.

Finally it was necessary for me to tell the manager that since he was looking to me for results and I was getting the results he wanted, it was not within his province to interfere. This seemed to settle the matter for the time. Later on this man was granted an increase, but after he had been told what that increase was to be, it was, for some reason cut in two and neither he nor myself was informed about it.

When he discovered the trick he said little but cut down on his day's work, then the old dissatisfaction which had been wiped away by his production record, came to the fore again. The matter was finally straightened out after the manager was convinced that even the sweeper would not do a full day's work if he were allowed to get the idea that the management was not giving him a square deal. It is just as necessary that the shop foreman see that his men give the management a square deal and also fight for it when necessary. This incident is typical of many of the smaller shops and its influence is rather far-reaching. This operator had, of course, told other employees what had happened to his increase and they took sides with him. Production dropped all over the shop and it was considerable time before the plant was running to the satisfaction of everyone again.

Shop Equipment Review Number

Four hundred forty-five items described during the last six months are reviewed in next week's Shop Equipment Review Number of the *American Machinist*. Be sure to have your copy kept on your desk as a catalog of the lastest in modern shop equipment and materials!

Classification of Gray Iron Alloys

By J. W. Bolton
Chief Chemist and Metallurgist, the Lunkenheimer Company

THE term gray cast iron covers a series of alloys of iron, silicon and carbon, with various percentages of other metals and metalloids. All these alloys in the as-cast condition contain graphitic carbon, associated with pearlite or ferrite, or both. While no recent comprehensive definition has been accepted as universal standard, most commercial gray irons contain between 2.50 and 3.75 per cent of total carbon, and 0.50 to 3.00 per cent of silicon. A very wide range of physical properties is found among the alloys of the series. Tensile strength, for example, may be from 20,000 to 60,000 lb. per sq.in. Brinell hardness varies from 100 to 240. The wide variations in physical properties suggest like variations in service obtainable in the field, and such is the case.

In order to specify intelligently, the engineer must be informed as to what grade best meets his requirements. Yet little such information is at his disposal. To define grades of iron, it is necessary to draw up a classification of the gray-iron alloys. Classifications might be established on various bases. The most logical seems a primary classification according to causative factors. These are:

1. Chemical composition—initial, incidental and final.
2. Structural and mechanical makeup of charge.
3. Melting process.
4. Thermal and mechanical history—furnace spout to cooled casting.
5. Design and workmanship.

Before proceeding to discussion of the many factors involved, it should be mentioned that the classification appears much more complex on paper than it works out in every-day shop practice.

As noted, gray cast iron contains carbon and silicon. Commercial irons also contain substantial percentages of phosphorus, manganese and sulphur. In addition to the above metals and metalloids other elements may be present. Nickel and chromium often are present as deliberate alloy additions, whereas small percentages of titanium, copper, and other metals, are reduced from certain ores; and also dissolved and occluded gases are to be found.

Structurally gray iron is an iron-carbon alloy, its principal microscopic components being pearlite, ferrite and graphitic carbon. Therefore, the percentage of total carbon has a very important bearing on all the physical and mechanical properties of the metal.

Within any iron-carbon alloy of the gray-iron series, of given carbon content and of similar foundry history, the relative amounts of pearlite, ferrite and graphite can be controlled to a great degree by the percentage of silicon present. In addition to its effect on melting point, and the position of thermal critical point, this element has a very marked influence on the degree of graphitization. Phosphorus is an important element, a constituent of the component known as steadite. It is well known that phosphorus has some effect on the fluidity of cast iron, and steadite diminishes the deflection under ultimate load and is generally held to lower the impact resistance. Manganese and sulphur, in ordinary amounts, appear to have slight influence on the usual mechanical properties of gray iron, hence no classification is needed. It must be remembered, however, that in the irons approaching the chill condition, the absolute and relative amounts of these elements influence the degree of graphitization, therefore they cannot be considered as wholly inconsequential.

In so far as other elements are concerned, it seems wholly impractical at present to attempt classification according to their occurrence, although they must be considered in all investigational and special specification work.

The cupola or furnace operation has much to do with the quality of metal. It is known, for example, that superheating during the melting process at first tends to delay the progress of graphitization on cooling. At still higher temperatures this phenomenon may be altered or changed. Iron badly oxidized in cupola melting does not compare favorably with that obtained from a good hot working cupola with normal blast. Crucible-melted irons generally are not comparable with those obtained from the cupola.

The thermal and mechanical history, from furnace spout to cooled casting, is another factor. The degree of graphitization depends largely on cooling velocity from liquid to a temperature probably somewhat below the eutectoid point. Cooling velocity and composition are the most important factors influencing the final properties of the metal. Cooling velocity is a curvilinear function, not easy to express in a simple manner. It depends on many factors. Among these are:

1. Initial temperature (which may or may not coincide with pouring temperature).
2. Final temperature.
3. Specific heat of the alloy, at all points along the curve.
4. Volume of metal to be cooled.
5. Metal surface area, for dissipation of heat.
6. Cooling gradients within metal and mold.
7. Conductivity of mold material.
8. Speed of pouring.
9. Energy release apparent in thermal arrests.
10. Mechanical factors.

It is apparent that with carefully regulated foundry practice many of these factors are nearly constant, or at least susceptible to a reasonable degree of control. The most significant factor is the relationship of volume to surface area, expressing the well-known foundry fact that cooling rate is proportional to section size.

Initial temperature depends to some degree on the process employed and on the method of operation Pouring temperature is controllable. Final temperature may be assumed as constant. The specific heats of various types of iron do not vary much.

The final item, design and workmanship, has much to do with the soundness, hence service properties of castings. But this well known item is quite thoroughly discussed in many articles and no further reference will be made here.

Abstract of a paper presented at the annual meeting of the A.S.T.M., Atlantic City, N. J., June 24 to 28.

The following narrative is a "case" presentation of the topic. It has been written to involve some of the questions that arise in the average shop. For guidance in preparing discussion the questions given at the foot of the page have been prepared

When Do Automatic Machines Pay?

"I TACKLED Williams this morning for an automatic machine for my department," said Ed at lunch, "and he didn't warm up a bit. I thought he'd jump at the idea, and be glad I was peppy enough to mention it. I don't quite get the reason for his attitude, Al."

"Could you show him a saving on the machine, Ed? Did you have figures to prove it would be economical, or did you leave it to him to guess at it?"

"I'm not good at figures. But how can an automatic help saving money over hand-operated machines. Stands to reason they must, or people wouldn't buy them as they do. And if they save money for others, why not for us? What would you have done, Al?"

"It's Williams' job to decide whether it pays to spend money for machines or not. So I'd try to show him a real saving before I asked for any new machine. And that applies to automatics as well as anything else."

"But how can they help saving money, Al, when they run themselves?"

"Wrong again, Ed. They don't run themselves. They have to be set up for the job by a real mechanic."

"But they do work faster, or else no one would buy them."

"Not always, Ed. I've known cases where an extra fast man on a hand machine could beat an automatic. Of course, he got tired sooner and the average man couldn't touch the machine, but it isn't as one-sided as some think. You'll have to figure it out before you know."

"I didn't suppose there was any question about it, Al. The automatic just runs along by itself and turns out a lot of work."

"If you mean an automatic screw machine, you're right except that someone has to feed it new bars of stock once in awhile, and unless you have several automatics you don't keep an operator and a setter-up busy. If it's a semi-automatic where you have to put the piece in and take it out, it takes all of your man's time, although in some cases he can handle two or more machines.

"Automatics are great time savers, Ed, and we're going to have more of them, but you've got to know they'll pay on the particular job you have in mind. You must figure out the interest on the investment and the upkeep as well as the cost of set-up and attendance. Then you balance this against the cost on the hand machine and you know whether it pays on that job or not. If you show Williams a saving he'll be interested right off the bat."

Is Al over-cautious about recommending an automatic? Or is Ed right in his idea that they must be economical? Are there any other factors to consider besides those mentioned?

Idea Suggested by L. O. Brown, Holcomb & Hoke Manufacturing Company

All foremen are urged to discuss these questions vital to their work; of course th discu

DISCUSSION OF EARLIER TOPICS

Paying a Bonus for Temporary Work

IT SEEMS to me that Kelly had a legitimate "kick." True, he had a steady job, but, if he had not been a good mechanic, sober, industrious and well behaved, he would have been let out with the less desirable, as is usual in dull periods. I believe that a good man with steady habits is a rarity, and the shop is lucky to get one in either good or bad times, or for steady or temporary employment. The wise foreman plans his work in such a way that this type of man is always kept on the job, so from my point of view, in only extraordinary cases would the man hired be up to Kelly's standard. If the bonus seems to be the proper inducement, Kelly and the rest of the old faithfuls, should "ring in" for the same treatment. —JACK SARGENT, *Foreman, R. Wallace & Sons Manufacturing Company.*

*

Keeping Posted on New Tools

AL WAS never nearer right in his friendly arguments with Ed than he is in the present one. It certainly does pay to know something about new things in advance. Just think what a relief it may be to Williams some busy morning when the new cutting alloys arrive and he starts out to explain them to Al and have Al tell him that he has been reading up on them. Al has the right idea even if it is from a selfish viewpoint. There is not so much difference between the really successful executive and his assistants, it is usually merely a matter of his knowing most things just a few days in advance of the other fellow. Reading up on new things in circulars and magazines is one way to get this "bulge." Many an executive stays ahead simply because he is alert enough to acquire information on something new while the other fellow with equal opportunity waits for it to come to him. Knowing something about a new thing, even if it is only a little, makes you feel so much at home with it that it does not leave you speechless when it is first introduced to you "officially." —K. H. NIXON.

IT IS strange how varied are the steps or methods which are employed by different organizations to do similar work. This same variety of process of thought and action also applies to individuals. Al and Ed are typical examples of this variety, and each no doubt is a valuable man to his empoyer. Ed's idea is to "buck in" to the job on hand, and when the work is done to forget it altogether, and enter into his sport with the same undivided attention that he gives to his daily work. Much can be said for this idea. It is a fundamental characteristic of all good workers, and therefore should be commended.

Al's case, however, is more interesting. Here we see a man who makes a hobby of his job, and consequently what to others is a task is to him an interest and inspiration. Al is a man who will always be at least one jump ahead of his job and at the same time will also find interest in sport or recreation which has no relation to his work. Al is certainly right in getting all the information bearing on any matter which will be, or is likely to be of help to him, but he should be equally a "bucker" when on the job, as Ed is. —ARTHUR BRAMWELL.

*

Going Over the Super's Head

IN MY humble opinion, when Black is a little older and has had more experience in dealing with people, he will look back at the Plow Company incident and admit to himself that he was unwise in going over the super's head. Please note that I say "unwise," not, wrong. For his own sake and the sake of the organization of which he was a part, he should have sat tight. Usually situations like this have a way of working themselves out gradually and with justice to all, if they are not forced.

There may be periods when it is hard to see any fairness in the situation, but I believe, from observing similar cases, that an understanding and recognition of the human factor in our relationship with others, requires a philosophy that takes into account the fact that it is not always sufficient just to be right. Black, in this case, was probably right, but he overlooked the seriousness of the human factor in his relationship with the super, who would naturally be antagonized by the action he took, whereas sitting tight might have caused the thing to come to a head in a short time and in a way that would have kept him out of the picture and preserved his good relations with the super. It is also important for the units of an organization to respect the authority of those immediately above them. Youth, in its impetuosity and inexperience, is more apt to "bust the works" than older men who may have as many good ideas and who are just as progressive, but have learned how to get them across with people. —W. A. KIRKPATRICK.

THE general superintendent who knows and trusts his staff would resent a foreman going over the head of his superior, and would probably remark: "Have you spoken to the superintendent about this?" or: "Why do you come to me with this information; why don't you take it up with the proper party?" The over-stepper is, in many instances, trying to discredit the one directly above him by ignoring his authority. To encourage such a procedure is doing an injustice to the one who is overstepped.

The general superintendent who consistently accepts

se the discussion is not limited to foremen. Letters accepted and published will be paid for

information through such channels is too small to hold his job; he tends to wreck the smoothness of the organization, and if a report of such tactics were to reach the ears of the superintendent affected, he would either feel hurt at the encouragement given the foreman by the general superintendent, or he in turn would go over his superior's head.

An organization large enough to require the employment of superintendent and a general superintendent, certainly should have a well working system, which would furnish the necessary means of conveying information to higher authority through the proper channels. And this should be done quickly. —J. HOMEWOOD, *Instructor, Chaffee Junior College.*

AFTER all, it was the super's place to decide which man should be assistant to Black, and it was a mistake on Black's part to try and over-rule his decision by going to the general superintendent, and furthermore, it was foolish for the general superintendent to side with Black as it weakened the super's position and was likely to cause future trouble. If Black is such a smart fellow, why doesn't he get out of the rut that he is in and get a superintendent's job in some other firm instead of trying to push an old employee out by going behind his back? The Plow Company could do without a man like Black, and who would blame the superintendent for seeing that it does? —L. E. MARKEY, *London, England.*

*

Should We Buy Tools by the Pound?

TOOLS, like machinery and other shop equipment that has a bearing on production cost, should not be bought by the pound. The principal factor in making a choice of cutting tools should be, which will be the most economical in the long run? Buying such tools at $500 a pound and not have the machinery to use it properly would, of course, be poor judgment. On the other hand, not to take advantage of this new material on a tough job would be shortsighted management. Five hundred dollars a pound sounds out of all reason for any material to be used in a machine shop. The average man will unconsciously compare it with the price of tool steel, but, the point that is not at first apparent is that with steel much of the tool will never come anywhere near the cutting edge, whereas with the tungsten-carbide tools, it is nearly all cutting edge. If the cost of a forged tool was charged against the ounce or two that is really used for cutting, and then a comparison was made, it would not look so staggering.

—L. F. SWANSON, *Industrial Engineer, Perkins Machine and Gear Company.*

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Letting a Big Order Go Elsewhere

A SUDDEN increase in business is always attended with undesirable results. The shop routine is upset, the costs mount, and the production rate per man always lags. A sudden demand for more work from the shop requires more men. Good men who are capable of going ahead with the work are scarce, and the men which the company is able to hire must receive training before they will be able to keep up their share of the work. Since they are unfamiliar with the tools and methods, the quantity and quality of their production is lower than that of the old men for quite some time after they are employed.

It is much better to have a slow and steady growth by adding a man here and there about the plant as the need arises. He can be trained better and cheaper, and more easily fitted to his place in the scheme of operation at a lower cost. Another important point is the fact that a firm that continually hires and lays off its force gets a bad reputation in regard to steady work, and this fact places the employment agent in a very embarrassing position. Good men fight shy of such a shop, and it must pay higher wages to get the right kind of help.

—L. O. BROWN, *Tool Room Foreman, Holcomb & Hoke Manufacturing Company.*

* * * *

THE · NEXT · TOPIC

"Why Some Tools Fail"

Letting a Big Order Go Elsewhere

SUMMARY OF THE DISCUSSION

Ed was wrought up because Williams had recommended the refusal of a large order. He contended that the shop needed the work and could secure the necessary additional men from some source. Al argued that Williams was right, and that the order should not be accepted unless the delivery time was extended sufficiently to avoid upsetting shop conditions.

MOST of the opinions expressed were against the acceptance of an order that would involve the hiring of a large number of new men; while on the other hand it was pointed out that firms do not expand by refusing orders. An engineer remarked that there were three ways of increasing output; overtime, an extra shift, and by increasing the facilities, but, it was pointed out that the last should always be a gradual process. The possibility of securing competent men was considered to be the most uncertain factor. Shop executives and others expressed the fear that sudden expansion would be attended by unsatisfactory results, and that the fact that the work would be of a temporary nature was also detrimental. One correspondent claimed that the temporary element made it difficult to bid on new work intelligently, because it was impossible to estimate the output of new men. On the affirmative side, the argument was advanced that the acceptance of such orders developed initiative by putting the shop on its mettle. Another suggested that such orders be accepted and the work "farmed out" to neighborhood firms for the general good.

GEAR GEOMETRY

A New Approach to Gear Analysis

By ALLAN H. CANDEE
Mechanical Engineer, Gleason Works

Completion of the geometrical analysis of gears in the third dimension together with tables for simplifying the practical application of the general case of an oblique involute rack to specific gear problems.

IT IS possible now to complete our system of terms and definitions by reference to the rack and the pitch figure. There is one plane to be added to those already defined.

25. The AXIAL PLANE OF ACTION is perpendicular to the side of a tooth in the axial plane and also is perpendicular to the axial plane.

This completes the list of eight planes, which are as follows:

Name of Plane	*Definition*
1. Plane of rotation	2
2. Pitch plane	19
3. Transverse plane	20
4. Axial plane	21
5. Tangent plane	22
6. Plane of action (transverse)	23
7. Normal plane	24
8. Axial plane of action	25

The plane of rotation will not be referred to in connection with the pitch figure, because in the case of a bevel gear there is no practical reason for considering it. This is evident from Figs. 16 and 18 in the first part of the article. The tangent plane contains the oblique triangle *XYZ* of the pitch figures (Fig. 27), but obviously being itself one of the parallel rack planes, contains none of the pitches. Each of the other six planes, however, passes the center point *O* of the pitch figure and cuts out a right triangle containing dimensions and angles which are involved in the calculations for and measurements in gear teeth. These six right triangles are illustrated individually in Figs. 28 to 33. The series of definitions is now continued, namely: (1) (Transverse circular) pitch, (2) Axial pitch, (3) Normal pitch, (4) Center pitch, (5) (Transverse) base pitch, (6) Axial base pitch and (7) Normal base pitch.

The second and concluding part of a paper presented at the annual meeting of the American Gear Manufacturers Association, May 16-18, in Cleveland.

26. PITCH in the oblique-tooth rack is the distance between two adjacent parallel tooth (tangent) planes measured in any specified direction.

27. (TRANSVERSE) PITCH (p) is the pitch taken in the direction of the pitch line in the transverse section.

28. AXIAL PITCH (p_x) is the pitch in the axial plane.

29. NORMAL PITCH (p_n) is the pitch in the normal plane.

30. CENTER PITCH (p_c) is the pitch in the direction of the line of centers, perpendicular to the pitch plane.

31. (TRANSVERSE) BASE PITCH (p_b) is the pitch in the direction of the line of action in the transverse plane, and so is the perpendicular distance between the parallel tangent lines forming the rack outline in the transverse plane.

32. AXIAL BASE PITCH (p_X) is the base pitch in the axial plane.

33. NORMAL BASE PITCH (p_N) is the base pitch in the normal plane, and is the perpendicular distance between the parallel planes forming sides of adjacent rack teeth. Likewise, it is the perpendicular distance between the parallel surfaces forming sides of adjacent involute gear teeth. It is therefore one of the most important fundamental gear tooth dimensions. Any two gears which are to engage each other properly must have the same normal base pitch.

PRESSURE ANGLES (See definition 15)

1. (Transverse) pressure angle	Fig. 29
2. Axial pressure angle	Fig. 30
3. Normal pressure angle	Fig. 31

34. (TRANSVERSE) PRESSURE ANGLE (a) is the pres-

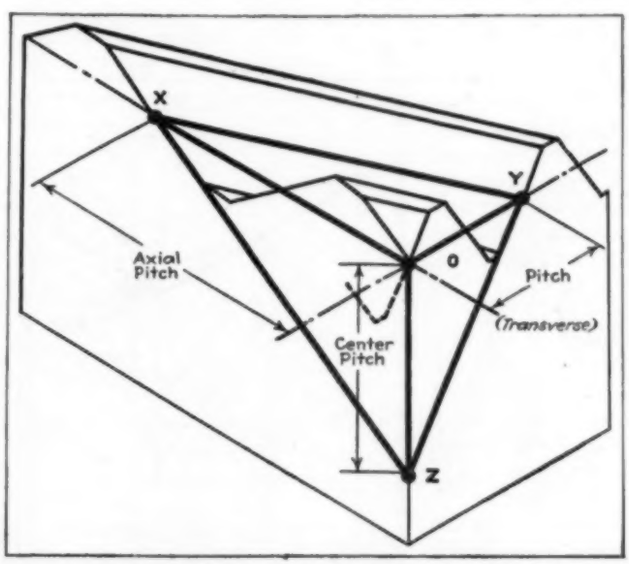
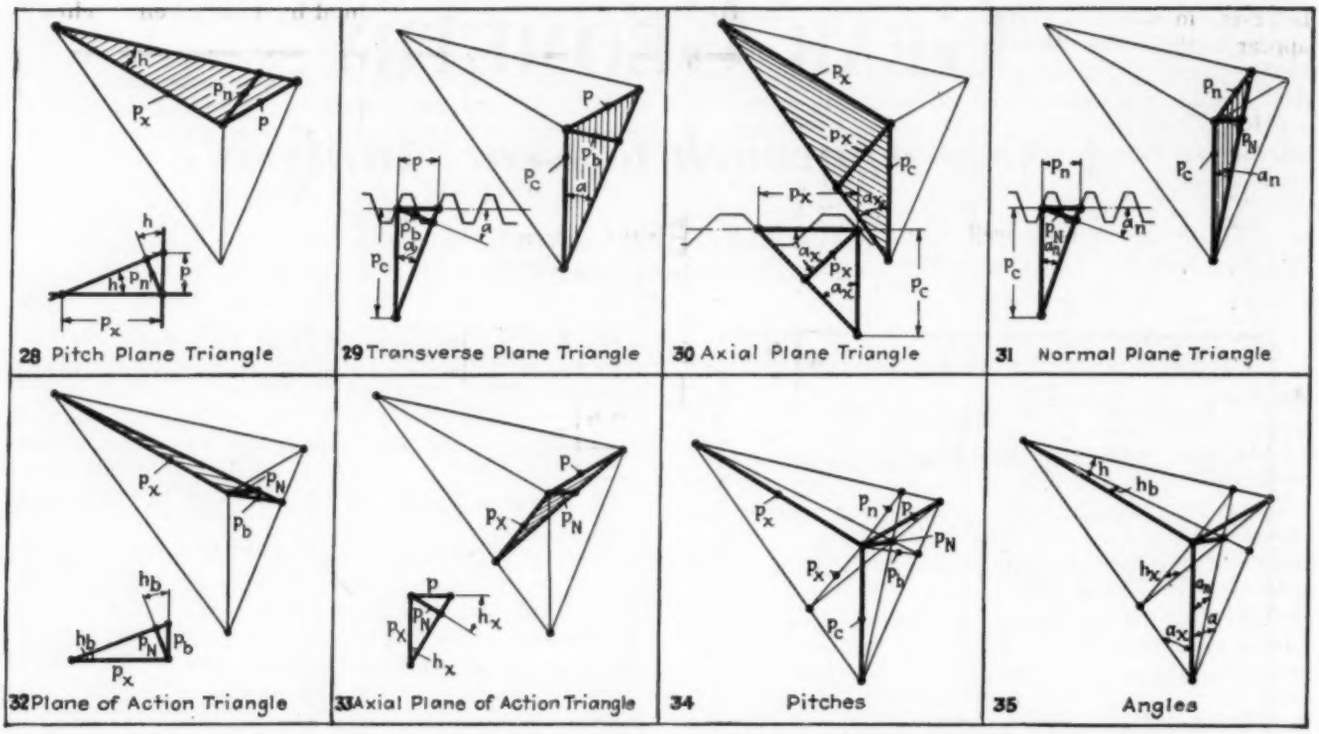


Fig. 27—The general case of gear analysis in the third dimension is represented by the so-called pitch figure, being a section of an oblique involute rack



Figs. 28-35—Step by step breakdown of the pitch figure into various pitch traiangles, each involving three pitches, or linear dimensions, and either a helix angle or a pressure angle. The relationships can all be expressed in a series of simple trigonometric formulas, collected in tabular form

sure angle in the transverse plane.

35. Axial Pressure Angle (a_x) is the pressure angle in the axial plane.

36. Normal Pressure Angle (a_n) is the pressure angle in the normal plane.

Helix Angles

1. (Pitch) helix angle	Fig. 28
2. Base helix angle	Fig. 32
3. Axial base helix angle	Fig. 33

37. The Helix Angle (h) is the angle of the helix on the pitch cylinder. In the oblique involute rack, the helix angle is the angle in the pitch plane between the tangent plane and the axial plane, or between the normal plane and the transverse plane.

38. The Base Helix Angle (h_b) is the angle of the helix on the base cylinder.

39. The Axial Base Helix Angle (h_x) is the angle in the axial plane of action, between the tangent plane and the axial plane.

LEAD ANGLES

1. (Pitch) lead angle
2. Base lead angle
3. Axial base lead angle

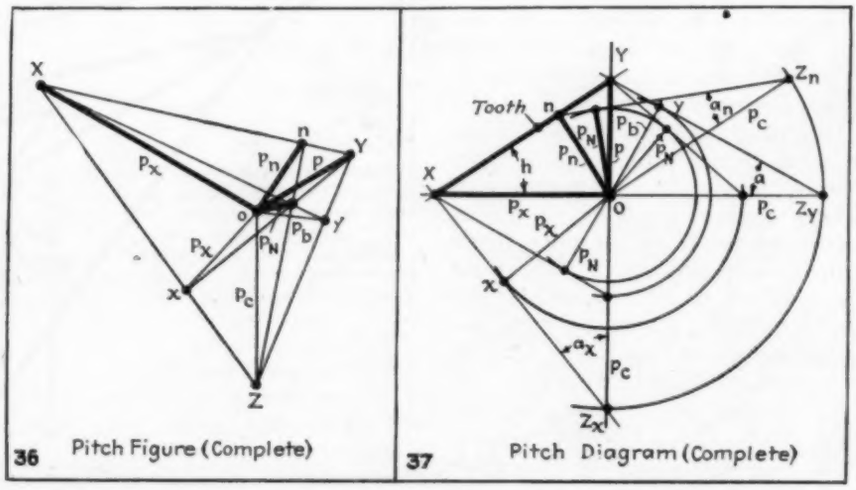
40. The Lead Angle (l) is the angle between the pitch helix and the plane of rotation. It is the complement of the helix angle; and is referred to in worms and hobs in preference to the helix angle.

42. The Base Lead Angle (l_b) is the lead angle on the base cylinder and is the complement of the base helix angle.

42. The Axial Base Lead Angle (l_x) is the complement of the axial base helix angle.

It can be seen in Fig. 34 how the seven pitches forming the pitch figure all intersect at the same point. Any two of them form an angle. Also, each of the individual pitch triangles of the preceding diagrams contains three pitches, or linear dimensions, and either a pressure angle or a helix angle. Of the four such elements in each pitch triangle, if any two are known, the other two can be determined. The trigonometric relationships among the pitches and angles can all be expressed in a collection of formulas like the standard formulas provided for the solution of triangles. The total number of these is rather large. They are recorded in convenient arrangement for reference in the accompanying tables.

Since the pitch figure is a perspective diagram it shows dimensions and angles in foreshortened aspects. A pitch diagram can be constructed,



Figs. 36-37—Development of the pitch figure shown in perspective into a pitch diagram on which all lines and angles are shown in the true magnitude

however, in which the elements all appear in their true values, as shown in Fig. 37 which corresponds to Fig. 35. Further detailed explanation will not be given, but there should be no difficulty in following the constructions indicated.

Anyone who has occasion to make gear calculations will be well repaid for time spent in becoming familiar with the pitch diagram and its component triangles. The ability to construct and use this diagram as occasion arises makes one independent of the lists of formulas which are too extensive to memorize.

The basic elements of a helical involute surface are two, namely: base diameter and lead, which are both linear dimensions. In a similar way the basic geometrical elements in a helical involute gear are three: base pitch, axial pitch, and normal base pitch, of which, of course, it is sufficient to give only two, as the third can then be determined. With two of these basic dimensions and the number of teeth given, all the other pitches and the angles at any specified diameter in an involute gear can be calculated. An example will make this clearer and will also serve to illustrate the way in which the kind of knowledge which has here been presented can be used.

Table II—Angles and Planes Determined by Two Given Pitches

	p	p_b	p_c	p_n	p_N	p_x	p_X
p	———	Transverse Plane	Transverse Plane	Pitch Plane	Axial Plane of Action	Pitch Plane	Axial Plane of Action
p_b	$\frac{p_b}{p} = \cos a$	———	Transverse Plane	———	Plane of Action	Plane of Action	———
p_c	$\frac{p}{p_c} = \tan a$	$\frac{p_b}{p_c} = \sin a$	———	Normal Plane	Normal Plane	Axial Plane	Axial Plane
p_n	$\frac{p_n}{p} = \cos h$	———	$\frac{p_n}{p_c} = \tan a_n$	———	Normal Plane	Pitch Plane	———
p_N	$\frac{p_N}{p} = \cos h_x$	$\frac{p_x}{p_b} = \cos h_b$	$\frac{p_N}{p_c} = \sin a_n$	$\frac{p_N}{p_n} = \cos a_n$	———	Plane of Action	Axial Plane of Action
p_x	$\frac{p}{p_x} = \tan h$	$\frac{p_b}{p_x} = \tan h_b$	$\frac{p_x}{p_c} = \tan a_x$	$\frac{p_n}{p_x} = \sin h$	$\frac{p_N}{p_x} = \sin h_b$	———	Axial Plane
p_X	$\frac{p}{p_X} = \tan h_x$	———	$\frac{p_X}{p_c} = \sin a_x$	———	$\frac{p_N}{p_X} = \sin h_x$	$\frac{p_X}{p_x} = \cos a_x$	———
	$h = 90° - l$		$h_b = 90° - l_b$		$h_x = 90° - l_x$		

Table III—One Pitch Determined by Given Second Pitch and Angle

	p	p_b	p_c	p_n	p_N	p_x	p_X
$p=$	———	$\frac{p_b}{\cos a}$	$p_c \tan a$	$\frac{p_n}{\cos h}$	$\frac{p_N}{\cos h_x}$	$p_x \tan$	$X \tan h_x$
$p_b=$	$p \cos a$	———	$p_c \sin a$	———	$\frac{p_N}{\cos h_b}$	$p_x \tan h_b$	———
$p_c=$	$\frac{p}{\tan a}$	$\frac{p_b}{\sin a}$	———	$\frac{p_n}{\tan a_n}$	$\frac{p_N}{\sin a_n}$	$\frac{p_x}{\tan a_x}$	$\frac{p_X}{\sin a_x}$
$p_n=$	$p \cos h$	———	$p_c \tan a_n$	———	$\frac{p_N}{\cos a_n}$	$p_x \sin h$	———
$p_N=$	$p \cos h_x$	$p_b \cos h_b$	$p_c \sin a_n$	$p_n \cos a_n$	———	$p_x \sin h_b$	$p_X \sin h_x$
$p_x=$	$\frac{p}{\tan h}$	$\frac{p_b}{\tan h_b}$	$p_c \tan a_x$	$\frac{p_n}{\sin h}$	$\frac{p_N}{\sin h_b}$	———	$\frac{p_X}{\cos a_x}$
$p_X=$	$\frac{p}{\tan h_x}$	———	$p_c \sin a_x$	———	$\frac{p_N}{\sin h_x}$	$p_x \cos a_x$	———
	$h = 90° - l$		$h_b = 90° - l_x$		$h_x = 90° - l_x$		

Suppose that a helical involute gear is to be cut with a spur-gear hob, and that it is desired to know the exact helix angle and pressure angle produced in the gear. Here "exact" should mean, for instance, that instead of assuming that the machine operator will install change gears to give the helix angle specified, the calculations are to be based on the change gears actually used. Then in the gear the known elements are:

N = the number of teeth

D = the pitch diameter at which the helix angle and pressure angle are to be calculated.

P_x = the axial pitch as calculated from the constants of the machine and the change gears selected.

Since a spur-gear hob is to be used, its normal pitch and normal pressure angle supposedly are equal to the pitch and pressure angle of the spur gears for which it was made. That is, the known elements in the hob are:

p_n = the normal pitch and

a_n = the normal pressure angle

at some unknown nominal diameter. The hob will be assumed to be of correct involute form, meaning that it is itself a helical involute gear. Then in the hob the normal base pitch is given by the formula

$$p_N = p_n \cos a_n$$

Since the hob generates the gear, this is also the value of the normal base pitch in the gear.

With p_x and p_N now known for the gear, reference to Table V next shows that the base pitch is

$$p_b = \frac{p_x \quad p_n}{\sqrt{p_x^2 - p_N^2}}$$

Of course, the pitch of the gear at the specified diameter is

$$p = \frac{\pi D}{N}$$

Then the pressure angle at the same diameter is ob-

Table IV—Angles Determined by Two Given Pitches

Name		Symbol	Sine	Cosine	Tangent
PRESSURE ANGLE	(Transverse)	a	$\frac{p_b}{p_c}$	$\frac{p_b}{p}$	$\frac{p}{p_c}$
	Normal	a_n	$\frac{p_N}{p_c}$	$\frac{p_N}{p_n}$	$\frac{p_n}{p_c}$
	Axial	a_x	$\frac{p_X}{p_c}$	$\frac{p_X}{p_x}$	$\frac{p_x}{p_c}$
HELIX ANGLE	(Pitch)	h	$\frac{p_n}{p_x}$	$\frac{p_n}{p}$	$\frac{p}{p_x}$
	Base	h_b	$\frac{p_N}{p_x}$	$\frac{p_N}{p_b}$	$\frac{p_b}{p_x}$
	Axial Base	h_x	$\frac{p_N}{p_X}$	$\frac{p_N}{p}$	$\frac{p}{p_X}$
LEAD ANGLE	(Pitch)	l	$\frac{p_n}{p}$	$\frac{p_n}{p_x}$	$\frac{p_x}{p}$
	Base	l_b	$\frac{p_N}{p_b}$	$\frac{p_N}{p_x}$	$\frac{p_x}{p_b}$
	Axial Base	l_x	$\frac{p_N}{p}$	$\frac{p_N}{p_X}$	$\frac{p_X}{p}$

tained by the following formula:

$$\cos a = \frac{p_b}{p}$$

and finally the helix angle is calculated from the relation

$$\tan h = \frac{p}{p_x}$$

This completes the information required for the geometrical determination of the gear. Questions regarding thickness of tooth and depth of cut constitute a separate study. Attention is called to the fact that the method of calculation here used indicates that the base pitch of the gear is not affected by the center distance between the hob and the blank nor by the angle betwen the hob and blank axes. In other words, the diameter of the base circle for volute teeth generated in the gear is independent of the hob setting.

Table V—Two Given Pitches Determine Third Pitch

	p	p_b	p_c	p_n	p_N	p_x	p_X
p	———	$p_c = \frac{p\,p_b}{\sqrt{p^2 - p_b^2}}$	$p_b = \frac{p\,p_c}{\sqrt{p^2 + p_c^2}}$	$p_x = \frac{p\,p_n}{\sqrt{p^2 - p_n^2}}$	$p_x = \frac{p\,p_N}{\sqrt{p^2 - p_N^2}}$	$p_n = \frac{p\,p_x}{\sqrt{p^2 + p_x^2}}$	$p_N = \frac{p\,p_X}{\sqrt{p^2 + p_X^2}}$
p_b	$p_c = \frac{p\,p_b}{\sqrt{p^2 - p_b^2}}$	———	$p = \frac{p_b\,p_c}{\sqrt{p_c^2 - p_b^2}}$	———	$p_x = \frac{p_b\,p_N}{\sqrt{p_b^2 - p_N^2}}$	$p_N = \frac{p_b\,p_x}{\sqrt{p_b^2 + p_x^2}}$	———
p_c	$p_b = \frac{p\,p_c}{\sqrt{p^2 + p_c^2}}$	$p = \frac{p_b\,p_c}{\sqrt{p_c^2 - p_b^2}}$	———	$p_N = \frac{p_c\,p_n}{\sqrt{p_c^2 + p_n^2}}$	$p_n = \frac{p_c\,p_N}{\sqrt{p_c^2 - p_N^2}}$	$p_x = \frac{p_c\,p_x}{\sqrt{p_c^2 + p_x^2}}$	$p_x = \frac{p_c\,p_X}{\sqrt{p_c^2 - p_X^2}}$
p_n	$p_x = \frac{p\,p_n}{\sqrt{p^2 - p_n^2}}$	———	$p_N = \frac{p_c\,p_n}{\sqrt{p_c^2 + p_n^2}}$	———	$p_c = \frac{p_n\,p_N}{\sqrt{p_n^2 - p_N^2}}$	$p = \frac{p_n\,p_x}{\sqrt{p_x^2 - p_n^2}}$	———
p_N	$p_x = \frac{p\,p_N}{\sqrt{p^2 - p_N^2}}$	$p_x = \frac{p_b\,p_N}{\sqrt{p_b^2 - p_N^2}}$	$p_n = \frac{p_c\,p_N}{\sqrt{p_c^2 - p_N^2}}$	$p_c = \frac{p_n\,p_N}{\sqrt{p_n^2 - p_N^2}}$	———	$p_b = \frac{p_N\,p_x}{\sqrt{p_x^2 - p_N^2}}$	$p = \frac{p_N\,p_X}{\sqrt{p_X^2 - p_N^2}}$
p_x	$p_n = \frac{p\,p_x}{\sqrt{p^2 + p_x^2}}$	$p_N = \frac{p_b\,p_x}{\sqrt{p_b^2 + p_x^2}}$	$p_x = \frac{p_c\,p_x}{\sqrt{p_c^2 + p_x^2}}$	$p = \frac{p_n\,p_x}{\sqrt{p_x^2 - p_n^2}}$	$p_b = \frac{p_N\,p_x}{\sqrt{p_x^2 - p_N^2}}$	———	$p_c = \frac{p_x\,p_X}{\sqrt{p_x^2 - p_X^2}}$
p_X	$p_N = \frac{p\,p_X}{\sqrt{p^2 + p_X^2}}$	———	$p_x = \frac{p_c\,p_X}{\sqrt{p_c^2 - p_X^2}}$	———	$p = \frac{p_N\,p_X}{\sqrt{p_X^2 - p_N^2}}$	$p_c = \frac{p_x\,p_X}{\sqrt{p_x^2 - p_X^2}}$	———

Standard Formulas

$$a = \frac{b\,c}{\sqrt{b^2 - c^2}} \qquad b = \frac{a\,c}{\sqrt{a^2 - c^2}} \qquad c = \frac{a\,b}{\sqrt{a^2 + b^2}}$$

In conclusion, there remain to be pointed out two ways in which the system of gear geometry which has been described is extended to include all possible cases. First, the pitch figure and pitch diagram have been given with one transverse plane and one axial plane. This is sufficient for the consideration of a single gear or for two gears with axes in the same plane; and in the case of two cylindrical gears with axes at right angles, it is only necessary to note that the transverse plane of one is the axial plane of the other, and vice versa. With the two axes oblique, however, only the tangent plane and normal plane necessarily remain common to both gears; and each gear will have its separate axial and transverse plane together with its own set of values for pitches and angles. This involves no additional principles but only means doubling up some of the elements.

Second, by slightly modifying the conception of the pitch figure, it can be seen to represent the correct relation of angles for any kind of tooth surface, and not necessarily for one of helical and involute form. This only requires thinking of the linear dimensions in the pitch figure as being velocities instead of pitches. All the ratios would remain as before, and there would be no change in the angles. Finally, the conception could then be led back to the idea of pitch by considering the linear dimensions in the pitch figure as distances moved, at respective velocities, during a period of time corresponding to one tooth interval. Thus it will be seen that the geometrical analysis which has been given is capable of completely general application.

Table VI—Two Given Angles Determine Third Angle

	a	a_n	a_x
a		$\sin a = \frac{\sin a_n}{\cos h_b}$ $\tan a = \frac{\tan a_n}{\cos h}$	$\tan a = \tan a_x \tan h$
a_n	$\sin a_n = \sin a \cos h_b$ $\tan a_n = \tan a \cos h$		$\sin a_n = \sin a_x \sin h_x$ $\tan a_n = \tan a_x \sin h$
a_x	$\tan a_x = \frac{\tan a}{\tan h}$	$\sin a_x = \frac{\sin a_n}{\sin h_x}$ $\tan a_x = \frac{\tan a_n}{\sin h}$	
	h	h_b	h_x
h		$\sin h = \frac{\sin h_b}{\cos a_n}$ $\tan h = \frac{\tan h_b}{\cos a}$	$\cos h = \frac{\cos h_x}{\cos a_n}$ $\tan h = \tan h_x \cos a_x$
h_b	$\sin h_b = \sin h \cos a_n$ $\tan h_b = \tan h \cos a$		$\sin h_b = \sin h_x \cos a_x$ $\cos h_b = \frac{\cos h_x}{\cos a}$
h_x	$\cos h_x = \cos h \cos a_n$ $\tan h_x = \frac{\tan h}{\cos a_x}$	$\sin h_x = \frac{\sin h_b}{\cos a_x}$ $\cos h_x = \cos h_b \cos a$	
	$h = 90° - l$	$h_b = 90° - l_b$	$h_x = 90° - l_x$

NOTATION

PITCHES

p = (transverse circular) pitch ....
p_b = base pitch
p_c = center pitch
p_n = normal pitch
p_N = normal base pitch
p_x = axial pitch
p_X = axial base pitch

ANGLES

Pressure Angles

a = (transverse) pressure angle
a_n = normal pressure angle
a_x = axial pressure angle

Helix Angles

h = (pitch) helix angle
h_b = base helix angle
h_x = axial base helix angle

Lead Angles (in worms)

l = (pitch) lead angle
l_b = base lead angle
l_x = axial base lead angle.

This summarizes all the notations to which previous reference has been made.

Production in the Job Shop

By Frank W. Curtis

When quantity production is added to contract work, it changes the character of the shop to a considerable extent

MANY of our large metal-working concerns started originally as a contract or job shop, and gradually began the manufacture of devices that, at first, acted as a production flywheel, and then eventually changed the character of the enterprise from a job shop to a factory. A good example of this evolution is the San Diego Machine Company of San Diego, Calif., which started out as a job shop in a territory where, at the time, there was little mechanical manufacturing, and only a limited market for any article or device they might, in the future, decide to manufacture. Notwithstanding this handicap of location the company eventually decided to manufacture an aluminum-alloy replacement piston.

In the beginning the officials of the firm were naturally conservative about purchasing any machines or equipment that were not actually necessary, or that, if purchased, could not be used for general purposes should the new venture not be successful. They realized that while the methods used in manufacturing may differ as between the large shop and the small one, the real test of management was not how cheap a thing could be made, but how near the cost approached the minimum possible with the equipment available.

This company, in addition to its contract work, now manufactures 116 different sizes or styles of pistons, all bearing a general resemblance to the one shown at Fig. 1. The different sizes and types are machined in quantities suitable to economic manufacturing purposes, and are then stored. When the established minimum for any style or size is reached, another lot order is placed. The operations employed by the shop in handling this production job will be described.

Fig. 1—Replacement piston made on a production basis in a contract shop

The pistons are cast in metal molds. The five-part core of one of these molds is shown in Fig. 2. The five sections are held together by a split retaining ring, and the outer sleeve of the mold fits snugly over the outside diameter of this ring and clamps the core sections in place. A cover plate with a riser gate completes the mold.

The pouring is done on a revolving table carrying a section of track holding two molds, each on its individual carrier. These carriers, which are shown in Fig. 3, proceed by gravity along two narrow angle-iron rails to the stripping machine, shown in Figs. 4 and 5. A sufficient number of molds are left between the molding and stripping operations to insure proper cooling of the casting.

The first stripping operation removes the cap. The mold is then turned upside down and the rod *B*, Fig. 4, is screwed into the central section of the core. Two arms *C* in Fig. 5 hold the outside parts of the core in place, while the central part is withdrawn. The rest of the mold is then easily separated from the casting.

After the riser left by casting has been removed, the piston is held on an expanding mandrel in a turret lathe, as shown in Figs. 6 and 7, and is rough turned, faced and centered.

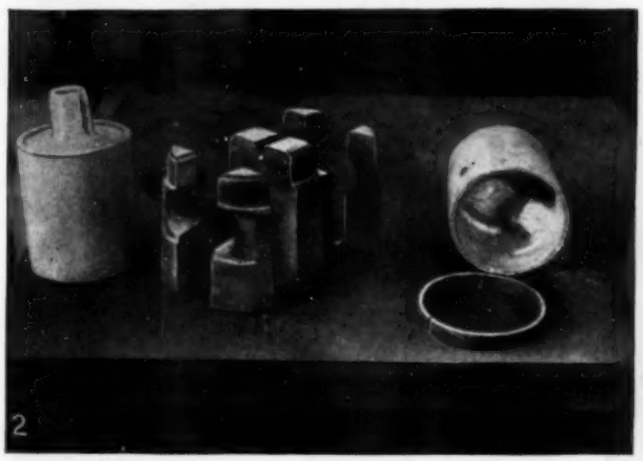


Fig. 2—Pistons are cast in a steel mold. The core is made in five sections held together by a band. Fig. 3—A steel sleeve is placed over the core assembly, being centered by the retaining band. A riser, through which the metal is poured, completes the mold

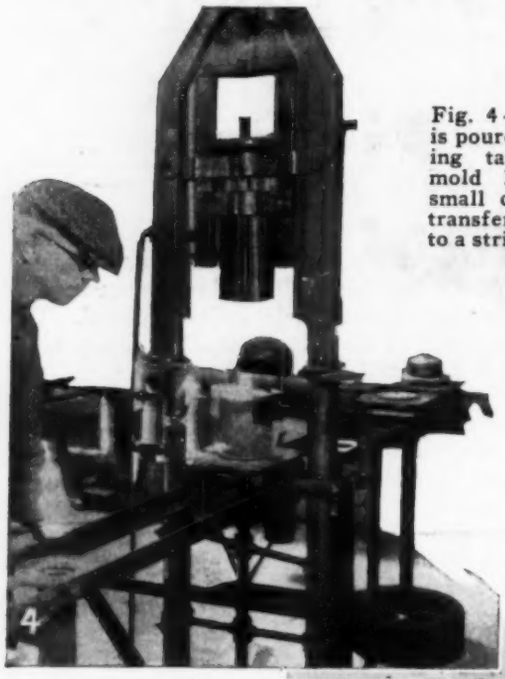


Fig. 4 — The casting is poured on a revolving table with the mold located on a small carrier that is transferred by gravity to a stripping machine

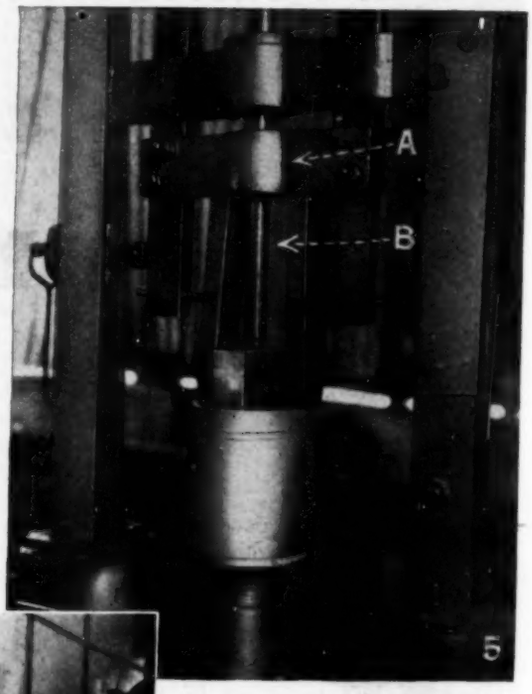


Fig. 5—The central core section is removed by a draw rod, while the side sections of the core are held in place

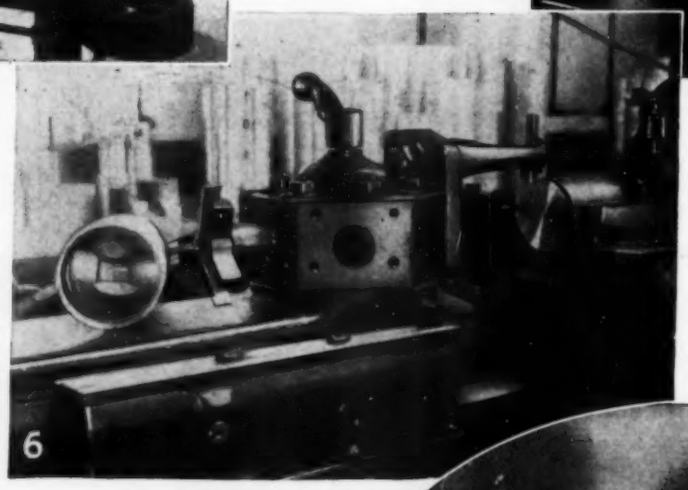


Fig. 6 — Turning, facing, centering and counterboring is done in a turret lathe. The facing of the top is done by three cutting blades mounted in a holder

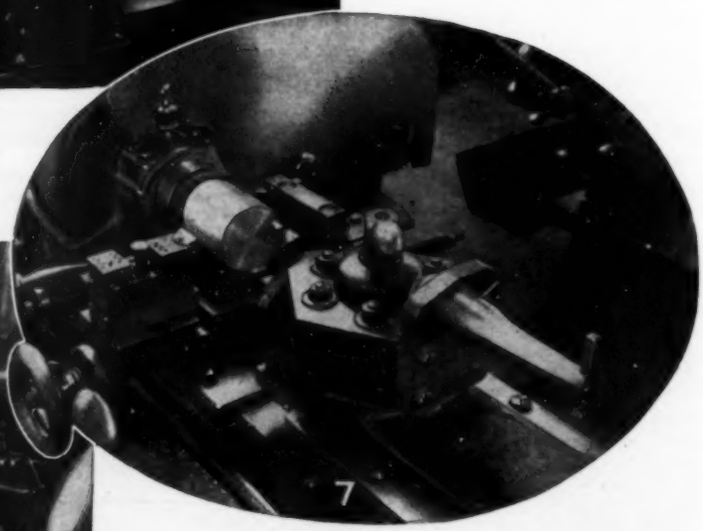


Fig. 7—View of the turning and facing operation, showing the rear toolpost on the cross-slide which faces the skirt and counterbores the open end

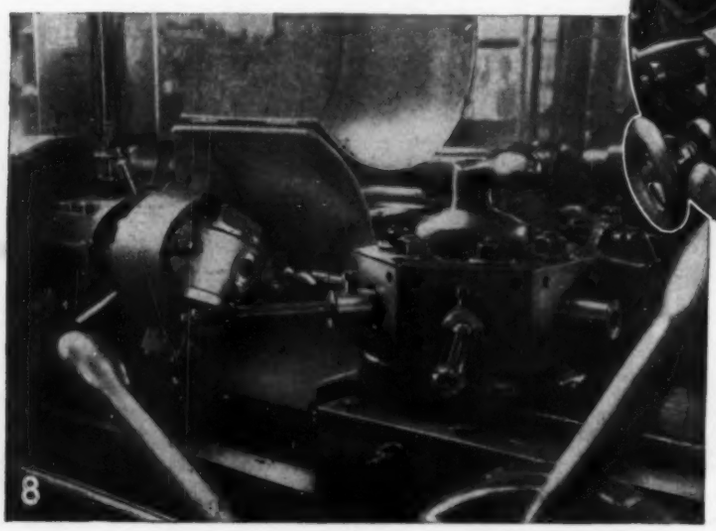


Fig. 8—The wrist-pin hole is finished in a lathe equipped with a chuck that locates and centers the piston

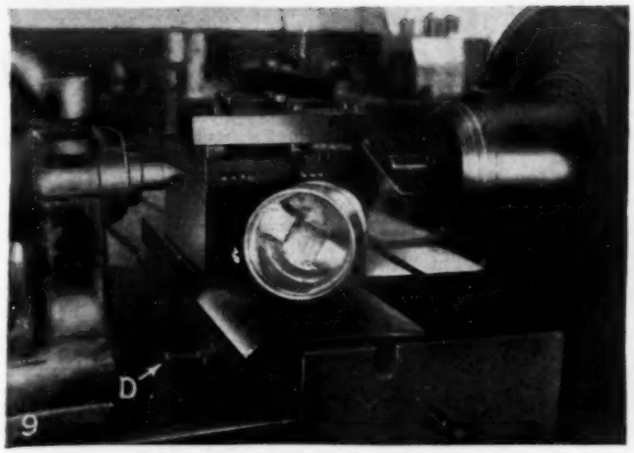


Fig. 9—Some lots are run through in small quantities. For this class of work the set-up shown handles the grooving and finishing operations. Fig. 10—A sawing attachment for machining the angular and radial slots. The work is held by a three-jaw chuck equipped with locating bushings

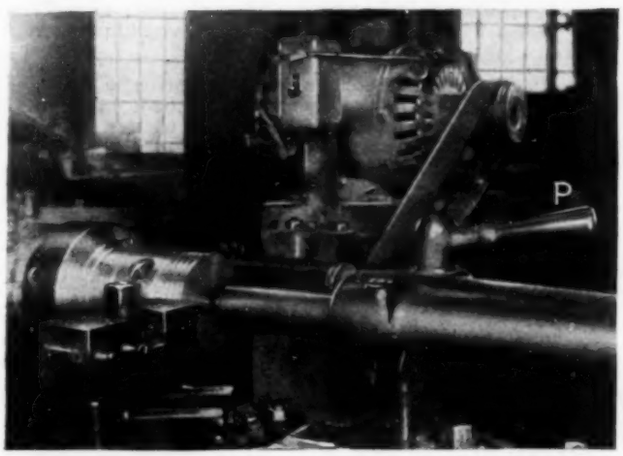


Fig. 11—Set-up used for finish grooving and cutting the relief around the wrist pins

The open end is counterbored with a hook tool to fit the mandrel used in the next operation, and the grooves are roughed out by a multiple tool carried on the cross-slide of the machine.

The wrist pin holes are drilled, bored and reamed on another turret lathe as shown in Fig. 8, the V-chuck being arranged to accommodate different sizes and lengths of piston. A thin sheet-metal strap holds it in place. In the next operation, the piston is located from the hole finished previously, and the other wrist pin hole is finished.

Both angular and radial slots are sawed in the skirt of the piston so that it will fit snugly enough to prevent slapping, without binding. This operation is done by an attachment mounted on a lathe bed, as shown in Fig. 10. The chuck is drilled on its periphery for indexing and holding purposes, and the fixture may be swung to saw the radial slots.

The final operation is to machine the relief around the wrist pin holes as shown in Fig. 11. A motor-driven milling fixture carried on the cross-slide of a lathe is used for this purpose. It is cam actuated similar to a tap or cutter relieving attachment.

The pistons, when shipped, are 0.075 in. large on the outside diameter, and the wrist pin holes are 0.002 in. undersize. The finishing is done at the point of use. This reduces cost and eliminates close tolerances.

The addition of quantity production to contract work gradually changes the character of the shop and modifies its methods. Materials are purchased in quantity instead of in small lots, machining operations are planned instead of haphazard, and contract work ceases to be the main consideration, and becomes an adjunct to quantity production.

What Is a Slot?—*Discussion*

By A. J. Black

THE author of the article, "What Is a Slot?" in the *American Machinist,* Vol. 70, p. 518, seems to be at a loss for the nomenclature of what is described as a piston ring groove, and believes that no mistake would be made in the use of the term "neck."

I have had some dealings with nomenclature for mechanical parts, and it is my experience that there will be as many definitions given to an item as there are members of the nomenclature committee. Therefore, as a member of the "committee of the whole," I will suggest that the neck be termed a *cannelure,* which, according to Webster's dictionary, has only one meaning, "a groove in a cylinder."

This, in my mind, differentiates between a groove in a cylinder and a groove in a flat plate, and makes it plain what is desired. Its plainness is based, however, on the supposition that mechanics know the meaning of the word "cannelure." The work "neck," when applied to ordnance, is defined as "a slender part of a cascabel between the knob and the fillet." Hence we must know our English.

In connection with nomenclature for simple mechanical terms, and the difficulty of obtaining a uniform set of definitions, I recall that for the terminology of the words "finish," "semi-finish" and "rough," when applied to bolts and nuts, there were received 65 definitions for this group of terms from representative engineers, manufacturers and users of the products. Therefore, the author of the article, "What is a Slot?" need not be discouraged in obtaining a proper definition satisfactory to all parties interested in mechanical terms.

In spite of the exactness which we would expect in the mechanical arts, they, like all other arts, lack concrete definitions of terms. Every definition agreed upon facilitates by that much the exchange of information within its field.

Mechanisms for Producing

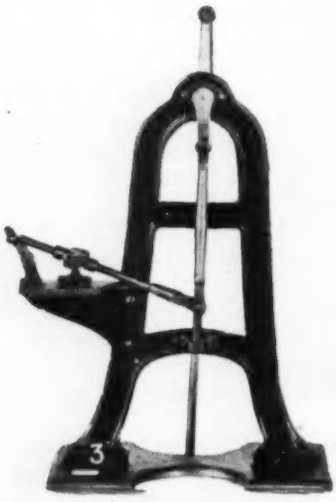
Photographs by courtesy of the Museums of the Peaceful Arts, New York. Models

Fig. 1—This is the most common mechanism for converting circular motion into straight-line motion and consists of a crank, connecting rod and crosshead

Fig. 2—In Watt's parallel motion mechanism the crosshead is connected to a floating link at a point whose distances from the connecting points of the two pivoted links are inversely proportional to the lengths of these links. The resulting motion is approximately straight line

Fig. 3—In this conchoidal link motion the end of the floating link, which slides through one pivot point, describes a straight line approximately

Fig. 4—Another conchoidal link motion, which is a modification of the mechanism shown in Fig. 3. In this case the floating link is carried on two pivoted links of equal length. This motion is also approximately straight line



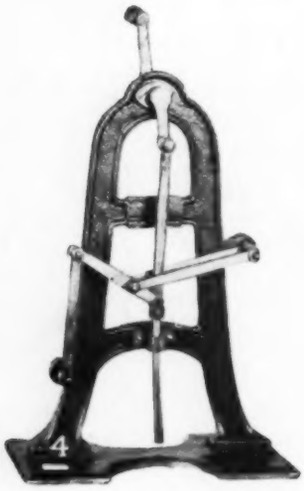
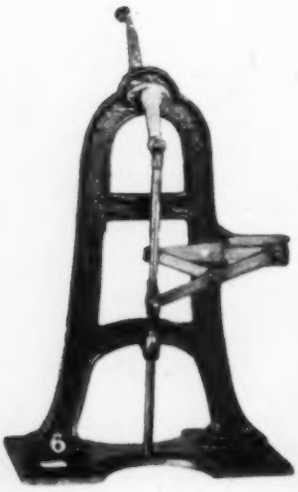


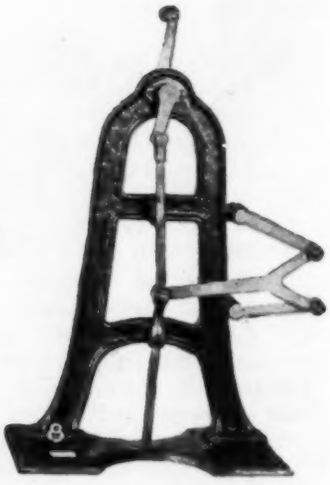
Fig. 5—Scott Russell's motion gives a theoretically straight-line motion. The short link is necessarily a floating one and the free end of the pivoted link slides in a slotted crosshead at right angles to the desired final motion

Fig. 6—In this grasshopper mechanism the conditions of Fig. 5 are reversed in that sliding action of one link, the floating member, takes place at the machine frame instead of at the crosshead member

Fig. 7—Another form of straight-line motion, employing, as in Fig. 3, a floating link sliding through one of its pivot points

Fig. 8—Robert's mechanism is another approximate straight-line motion. Its chief feature is the Y-link floating on two pivoted links of equal length





ng Straight-Line Motion

Models are the property of the Sheffield Scientific School, Yale University, New Haven

Fig. 9—In this symmetrical oscillating link motion an oblique crossbar, rigidly fastened to the crosshead of the mechanism, is carried at both ends on floating links the other ends of which are pinned to a link, which has a fixed pivot at its center

Fig. 10—The two upper links of this parallel link mechanism practically act as a solid piece since they are joined by the crossbar of the *A*

Fig. 11—A modification of Fig. 10. Here parallel motion of the two links is obtained by gear sectors

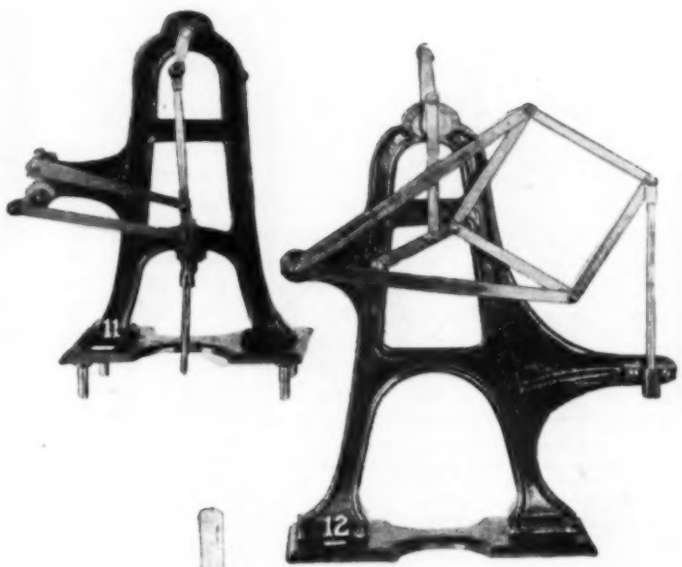
Fig. 12—Like Russell's motion in Fig. 5, Peaucellier's mechanism gives a theoretically straight line. In appearance it is a series of expanding toggles, but actually the toggle motion is slight compared with the throw of the crank

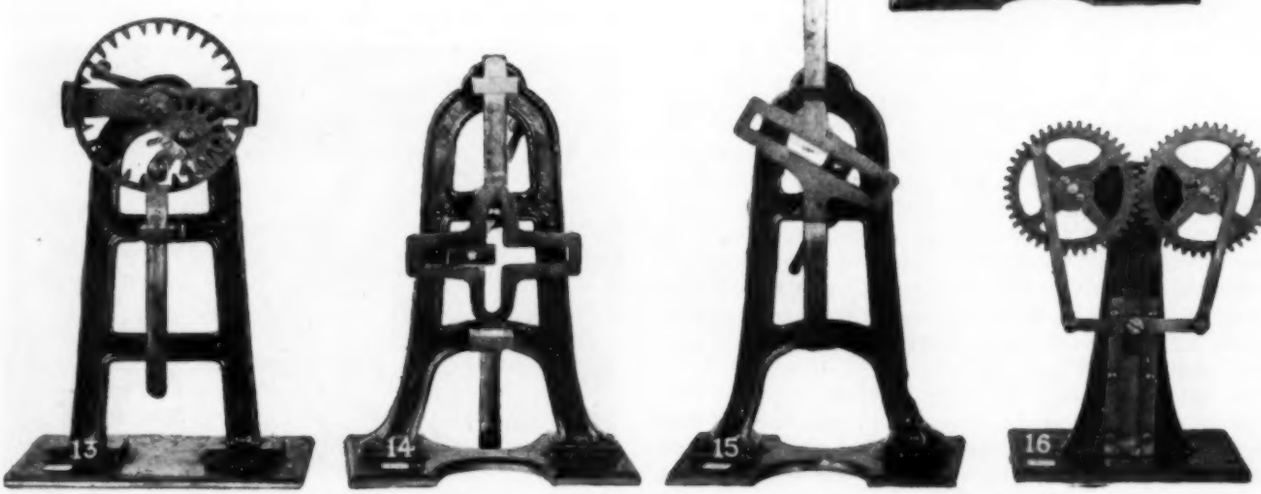
Fig. 13—This hypocycloid straight-line motion takes advantage of the fact that, if a circle is rolled around the inside of another circle of twice its diameter, a point on its circumference will describe a line which is the diameter of the larger circle

Fig. 14—The so-called Scotch yoke is the special case of Fig. 1 with a connecting rod of infinite length. Uniform motion of the crank gives pure harmonic motion to the rod

Fig. 15—Another form of Scotch yoke with the slide at an oblique angle. The slide is at the top of the stroke when the crank is at right angles to it. This motion is used in valve gears for steam engines

Fig. 16—A gear form of straight-line motion. It is obvious that the two pin points on the gears are always symmetrically placed





IDEAS FROM PRACTICAL MEN

The department, "IDEAS FROM PRACTICAL MEN," is devoted to the exchange of information on methods useful to the machinery industries. Its scope includes all divisions of the metal-working industry, from drafting room to shipping platform. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for. The rates are from a minimum of five dollars upwards, depending upon their merit.

Reaming a Curved Hole

By R. W. BUETTNER
Works Manager, Nordberg Manufacturing Company

IN THE construction of rolled steel plate drums, as used on mine hoists, the rolled steel plate forming the drum face is mounted on cast-steel end rings. In order to bring the hoisting rope to the inside of the drum for fastening, a grooved cored hole is provided in the end ring. Through an error, this hole was made $1\frac{3}{4}$ in. in diameter, whereas it should have been at least $2\frac{1}{4}$ in., in order to allow sufficient clearance to permit the rope being readily passed through. Owing to the length of the hole and the fact that it was curved, it was impossible to enlarge it by chipping. Boring seemed to be the only solution; this, too, presented a difficult problem, but it was eventually solved with the device shown in the illustration at the left.

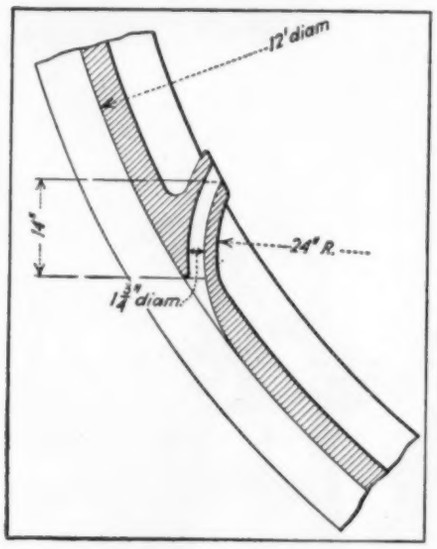


Fig. 2—Cross-section of a cored hole in a steel casting that required enlarging

This device consisted of a piece of $\frac{7}{8}$ in. cable about 28 in. in length, to the ends of which were fastened suitable connections and the cutter. The wires at one end of the cable were soldered to prevent them raveling, and then held into connection *A* with four hollow-head setscrews. The end of this connection had a left-hand thread on which was screwed a left-hand cutter $2\frac{9}{32}$ in. in diameter, beveled to 45 deg. It was necessary to use a left-hand thread and cutter owing to the cable being wound left hand, which had to be rotated in this direction so that it would not have a tendency to unwind. The other end of the cable was brazed into connection *B*, which in turn was held in shank *C* with four hollow setscrews. Between the two connections were six $1\frac{3}{4}$-in. rollers and sleeves made of short pieces of 1-inch pipe. This completes the tool itself.

In order to prevent the cable buckling, a copper tube slightly smaller than the diameter of the finished hole was bent to the approximate curve of the cored hole. The clearance between the inside of the tube and the rollers was about $\frac{1}{16}$ in. Before starting boring with the flexible attachment, each end of the cored hole was bored to the size of the cutter until the full diameter of the hole was reached. This was done in order to permit easy starting of the cutter. The device was then slipped into the tube, the end of which was inserted in the hole and the boring was done on a horizontal drill press. As the cutter was fed into the hole, the tube followed being forced in by the drill spindle. The length of the grooved hole, shown in Fig. 2, which was drilled by this device was about 14 inches.

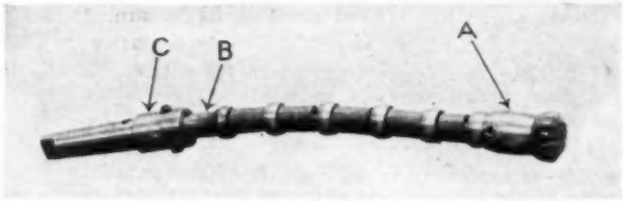


Fig. 1—Flexible reamer for cored holes. A copper pipe casing prevents kinking

Attachment for Relieving Printing-Press Cylinders

By GEORGE H. FELTNER

Cylinders of certain types of printing presses require to be relieved, or undercut, for a certain part of the circumference. The work is done in a lathe fitted with a cam-operated relieving attachment, as shown in Fig. 1. The tool-slide is attached to the rear end of the carriage and is actuated by a rack and a pinion, the pinion being feathered on a shaft running parallel with the lathe bed.

A gear segment, meshing with a pinion on the end of the shaft, carries a roller to engage a built-up cam attached to the faceplate of the lathe, as shown in Fig. 2.

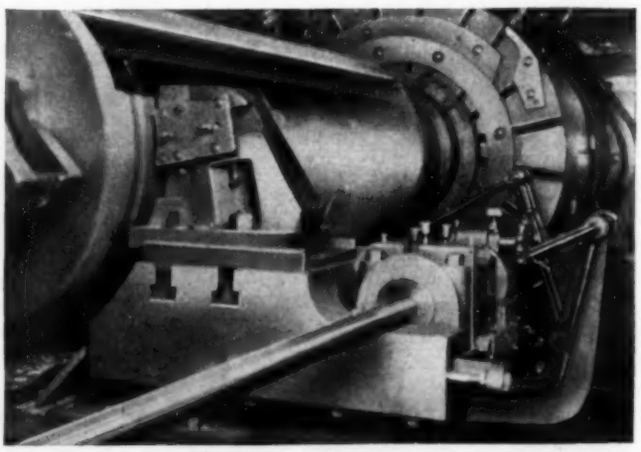


Fig. 1—Attachment for relieving printing-press cylinders

In both views the roller is shown in contact with the smaller diameter of the cam. When the step in the cam comes in contact with the roller, the segment is partly rotated, communicating its motion to the pinion and the shaft. Since the pinion that operates the toolblock is feathered on the shaft, it rotates with it, moving the toolblock outwardly and bringing the tool into position for turning the larger diameter of the roll.

The roller now rides on the larger diameter of the cam for part of a revolution of the lathe, or until it is met by another step in the cam. At this point it is transferred to the smaller diameter of the cam. At this change in the roller, the shaft is again partly rotated, through the segment and its mating pinion, but in the

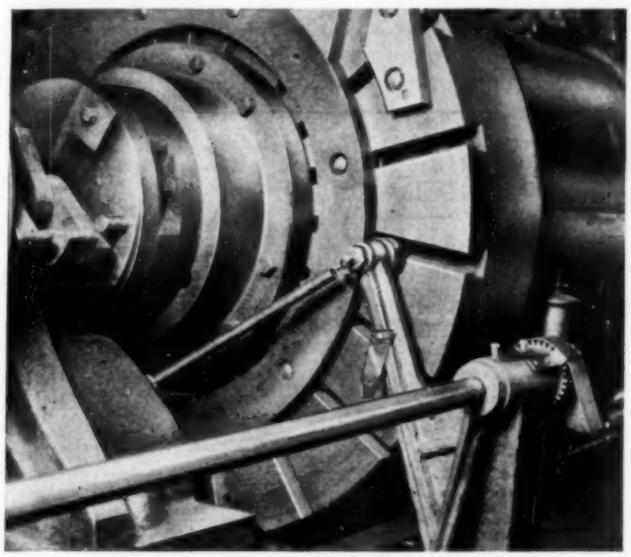


Fig. 2—Close view of the cam and the segment

opposite direction, moving the toolblock inwardly and bringing the tool into position for cutting the relief on the roll. The cam roller is kept in contact with the cam by a spring attached at one end to the segment and at the other end to a stationary part of the lathe. The proportion of the relief to the larger diameter of the roll is governed by the angular positions of the cam steps.

Head for Interchangeable, Formed Cutters

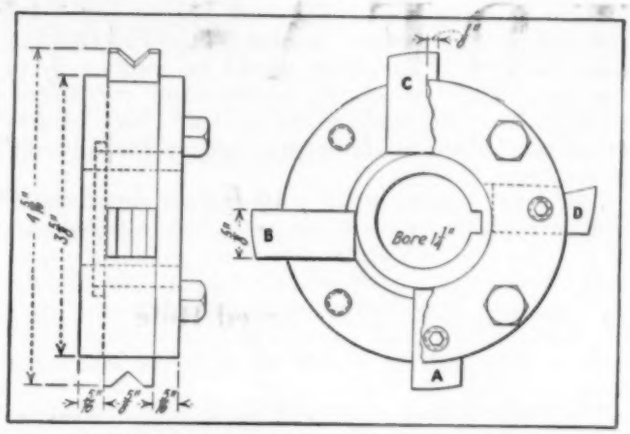
By Martin H. Ball

Mechanical Engineer, Sweet & Doyle Foundry and Machine Co.

The illustration shows a cutter head in which formed and relieved cutters of various contours can be made and interchangeably used.

In turning the contours of the cutters, they are placed in pockets in the head in the positions shown at *A*, *B* and *C*, and are held by safety setscrews in the cap. After the cutters have been turned to the desired contour, they are removed, hardened, and their faces are ground to present radial lines to the work. They are then replaced in their pockets in reverse position to that in which they were turned, as shown by the cutter at *D*. It will be understood that reversing the cutters from the position in which they were turned, automatically gives relief to their cutting edges.

The body of the cutter head has pockets for the



Cutter head for interchangeable, formed cutters

cutters, and a hub which forms an abutment for their inner ends. Around the hub, in the face of the body, a circular groove is cut to give clearance space for the cutters used in milling the pockets. The cap fits over the hub in the body. Any quantity of interchangeable cutters of different contours can be made and kept in stock and will be found useful for a great many purposes.

The size of the head, the number of cutters and the amount of their offset can be varied to suit the requirements of the individual user.

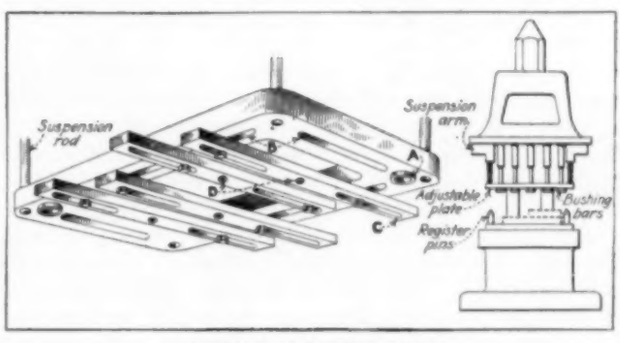
Jig Plate With Adjustable Bushing Bars

By Wm. F. Sandman

Secretary, Marshall & Huschart Machinery Company

Many shops hesitate to place their short-run production jobs on multiple-spindle drilling machines because of the cost of the necessary jigs. In such cases, a jig plate with adjustable bushing bars will often make it possible to multiple-drill these jobs at a very small expense for the set-up.

Such a plate is shown in the illustration. It is suspended from the head of the machine by the conventional rods. A holding fixture is used for locating and clamping the work, and pins in the fixture register in the bushings *A* as the head of the machine is lowered. The plate is about 1¼ in. thick and can be made of either cast iron or steel. Slots at the sides and ends, as shown at *B*, are provided for clamping bolts for holding the bushing bars in place. The bars *C* are ¾ in. thick and 1½ in. wide, and carry the drill bushings, as at *D*. Their length can be varied to suit conditions. Slots are cut through the ends of the bars



A universal bushing plate

for the clamping bolts. The bars can be bored for bushings in several places, so that different set-ups can easily be made. The holes should be accurate as to size, and large enough to accommodate the largest bushings that are likely to be needed. Any suitable device can be used to prevent the bushings from turning in the bars.

The usual method of using the plate is to place the holding fixture on the machine table with a drilled part in it. The plate is then let down over the register pins and drills of the proper sizes are slipped through the bushings, adjusting the bars so that the drills will enter the holes in the drilled part. The bars are then tightened in place and the spindle set-up of the machine is made as usual.

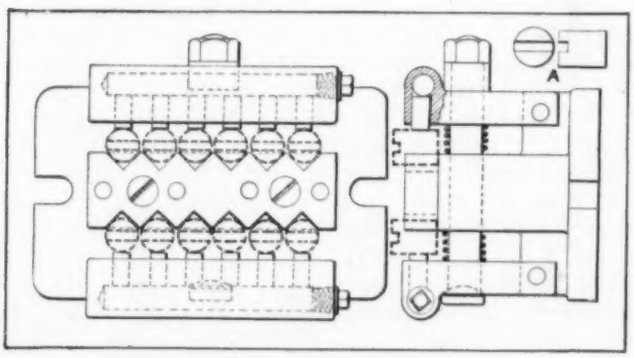
The bushing bars used on plates of this kind do not necessarily have to be straight, but can be made to various shapes to suit conditions. Often they are offset vertically, so as to allow the bushings to reach deep places in the work where holes are to be drilled. Sometimes they are offset horizontally to make possible a different set-up. Plates of the type described will be found especially useful when drilling parts, the holes in which may be subject to change in size or location.

Milling Fixture With Equalizing Clamps

By D. Bradford

Having a large quantity of short, round pieces to make, such as the one shown at *A*, each having a slot in one end, we built the multiple holding-fixture illustrated herewith. Since the pieces varied slightly in diameter, it was necessary that some sort of equalizing clamps be used to hold them equally tight.

Attached to the center of the fixture is a block having V-notches on both sides, twelve in all. On each side of the block are clamps pivoted to the fixture base and extending the whole length of the block. Each clamp has a hole drilled nearly its whole length and is tapped



Fixture provided with equalizing clamps

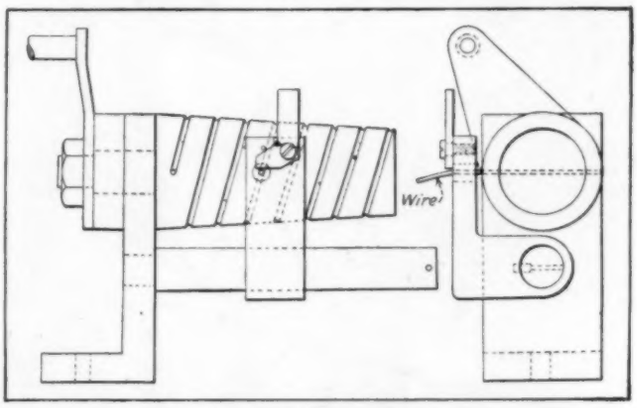
at the open end for a pipe plug. Six equally-spaced holes, opposite the centers of the V-notches, are drilled in each clamp, connecting with the longitudinal hole therein. In these holes are fitted hardened and ground plugs. The longitudinal holes are filled with melted beeswax and are closed by screwing in the pipe plugs.

The clamps are connected by a bolt passing through them and through the central block, and are normally held outward by stiff helical springs. With the pieces to be slotted in place, tightening the nut on the clamping bolt pinches them between the V-notches in the central block and the hardened and ground plugs in the clamps, the flowing of the beeswax equalizing the pressure on the plugs and holding the pieces equally tight. Loosening the nut on the clamping bolt permits the springs to force the clamps outwardly, thus releasing the pressure from the work and allowing it to be removed.

A Hand-Operated Fixture for Winding Conical Springs

By H. L. Wheeler

A small machine shop had been supplying an old customer with special conical springs made from brass wire for many years. The springs were usually ordered in lots of about 200. The method of making them was by winding the wire on a hardwood mandrel held in the spindle of one of the three lathes in the shop. Consequently, when springs were being wound, the lathe was



Fixture for winding conical springs

tied up on the job for several hours. The springs were usually wanted in a hurry, and whenever an order was received, it meant that some important lathe job had to be sidetracked to get out the springs.

By making the simple, hand-operated fixture shown in the illustration, the springs were produced at a less cost than by the former method, and at the same time, a good lathe was released for other work.

The fixture consists of an angle iron provided with a hole for a bearing; a conical mandrel having grooves corresponding to the pitch of the spring; a crank for turning the mandrel; a wire carrier provided with a hardened bushing for guiding the wire; a stud on which the wire carrier slides; and a cutter pivoted to the wire carrier.

In use, the wire is passed through the bushing and through a hole in the large part of the mandrel. As the mandrel is revolved, tension being put upon the wire by hand, the wire follows the grooves in the mandrel and pulls the carrier along with it. A pin near the end of the stud prevents the carrier from running off. When the wire has been wound to the end of the mandrel, a sharp blow with a hammer on the upright part of the cutter, cuts off the wire. The hole in the bushing should be well rounded at the inner end to prevent the wire from being scored as it is wound upon the mandrel.

After being wound and the wire cut, the spring will expand sufficiently to release itself from the grooves. It is necessary, therefore, to make the mandrel smaller than the required size of the spring in order to compensate for this expansion.

Design of Shafts for Strength

Splines, Keyways, Fillets and Shoulders

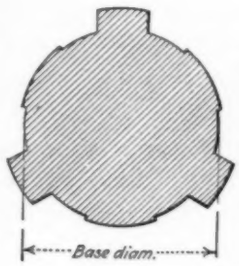


Fig. 1—The base diameter should be used in calculations

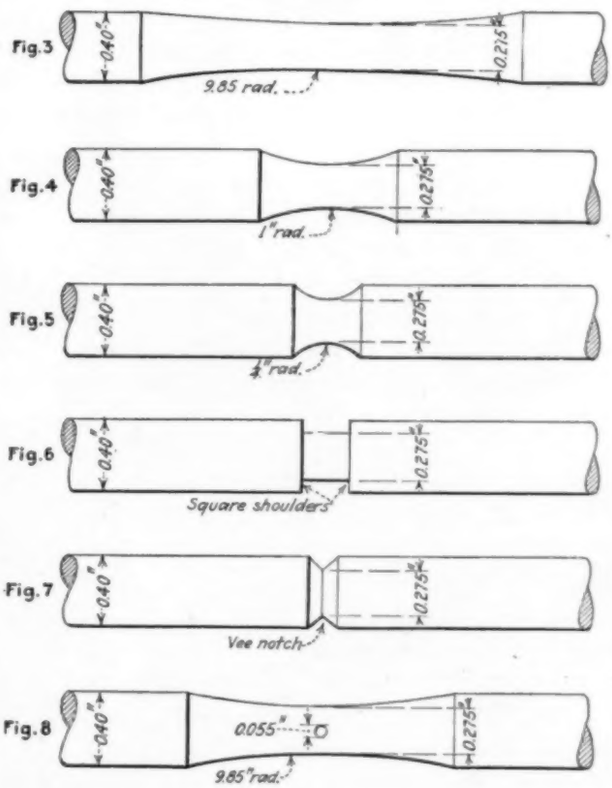
Both the static and fatigue strengths of shafts are influenced by variations from the true cylindrical surface. For splined shafts it is good practice to use the base diameter, as defined by Fig. 1, in calculations instead of the outside or an intermediate diameter.

In the case of shafts with a single keyway of the usual proportions, that is, with the width equal to one-fourth of the diameter of the shaft and depth equal to one-eighth of the diameter of the shaft, the strength is reduced 18¾ per cent. The following formulas and results have been deduced from test data:

$$\text{Efficiency} = \frac{\text{elastic strength of shaft with keyway}}{\text{elastic strength of shaft without keyway}}$$

$$= 1.0 - 0.2\ \frac{w}{d} - 1.1\ \frac{h}{d} \qquad (1)$$

In Fig. 2 the efficiency is expressed graphically.



The ratio of the twist of a shaft with keyway compared the twist of a similar shaft without a keyway,

$$R = 1.00 - 0.40\ \frac{w}{d} - 0.70\ \frac{h}{d} \qquad (2)$$

Where w = width of keyway, h = depth of keyway and d = diam. of shaft.

Several further examples, covering the weakening effect of square shoulders, holes through the shaft, and other abrupt changes of section which should be carefully considered, are illustrated by Figs. 3 to 8

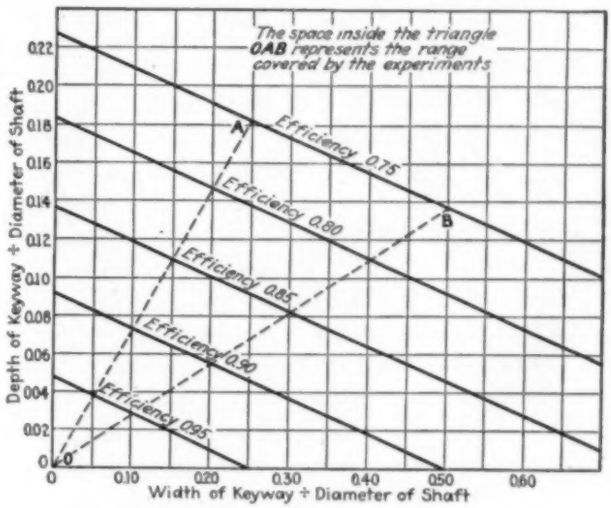


Fig. 2—Efficiency of shafts with a single keyway

inclusive. The fatigue strength of the shaft shown in Fig. 3 is practically the same as for a plain straight shaft 0.275 in. in diameter. The fatigue strength of the shaft of Fig. 4 is nearly as high as the specimen of Fig. 3 with a 9.85 in. radius or as a plain straight shaft 0.275 in. in diameter, whereas the fatigue strength of the shaft shown in Fig. 5 is about 8 per cent less than that of the plain straight shaft 0.275 in. in diameter. Likewise, the fatigue strength of the shaft of Fig. 6 is about 50 per cent less, and that of the shaft shown in Fig. 7 about 60 per cent less than that of a plain straight shaft 0.275 in. in diameter. The small hole drilled through the shaft shown in Fig. 8 reduces the fatigue strength about 50 per cent. The interesting and helpful point to be noticed in connection with these experimental results is that other shafts of similar proportions will give similar results. Thus, an inch shaft with a $\frac{3}{16}$-in. hole, being of the same proportions as the shaft shown in Fig. 8, will be weakened about 50 per cent by the $\frac{3}{16}$-in. hole.

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Editors: KENNETH H. CONDIT AND FRED H. COLVIN

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The Effect of a Vacation With Pay

SUMMER vacations, with pay, for the whole force, do actually increase production and profit for the year, according to the experience of a machinery building plant of moderate size in New England. The superintendent of this plant had a struggle to persuade his superiors that such a scheme was anything else but pure altruism, a characteristic that is not commonly considered essential to business in that part of the country—or in most other parts, for that matter.

Briefly, the results of the plan have been eminently satisfactory to all concerned. Production has increased, and so have profits as compared with other years when no vacation was granted. But the superintendent is not fooling himself that a grateful force of workmen have pitched in with renewed vigor after their vacation to show how much they appreciate it. He wisely points out that there is less lost motion when all the regular foremen are on the job, and fewer spoiled jobs, than when four or five of them are away at a time, as would be the case under the usual vacation system where foremen get two weeks and their absences are spread over the whole summer.

Which, after all, sounds very reasonable and indicates once more how important a factor the foreman is in the scheme of things.

*

The Lure of the Patent

THE glamor of fortune hunting, of digging for Captain Kidd's buried treasure, seems to be equaled by the lure of the patent as a possible means of coaxing untold millions from a world that sometimes seems cheerless and humdrum when only a modest salary is forthcoming. Getting a patent is, in the minds of many, the royal road to private yachts and limousines, and so thousands continue to waste their time and spend their good money in devising a new mousetrap, a windshield wiper or a locknut.

Years ago, in the earlier days of railroading, every country town had its inventor of a car coupler that was to prevent accidents and, above all, make a Croesus of the inventor. Just at present, however, the nutlock seems to be the favorite subject for freak designs and the patent office and lawyers' fees that accompany them. Fearful and wonderful designs of locknuts continue to appear, many of which might unquestionably lock a nut on a bolt. In most cases, however, it is evident that the designer has no conception of costs and does not realize that a practical locknut must be made cheaply and be easily applied.

Locknuts are of course only typical of the waste that goes on due to the lure of getting a patent. Nor does there seem to be any way of checking the waste. For who wants to trust a patent office clerk, or anyone else, to censor applications in order to eliminate those of inferior or impractical design? For it frequently happens that the device that we are sure will not work—does. Even government insurance of a patent, as has been proposed, could only guarantee the novelty or inventive feature, and not its commercial value.

*

Prosperity and Installment Selling

OF THE many important facts brought out in the report of the Committee on Recent Economic Changes one of the most significant is the responsibility for present prosperity credited to installment selling. Apparently the members of the committee were not frightened away from a calm analysis of the whole situation by the unfortunate results of the relatively small proportion of this type of financing that was done by inexperienced and unskillful operators, and on unsound credit terms.

Most of the manufacturers of production equipment have been slow to enter the field of installment selling. From the point of view of the seller it is pleasanter, of course, to conduct all business on a cash basis, but there is sure to be a certain proportion of the potential business that must be lost if no facilities for credit are available. In some instances this proportion represents the difference between profitable operation and an even break.

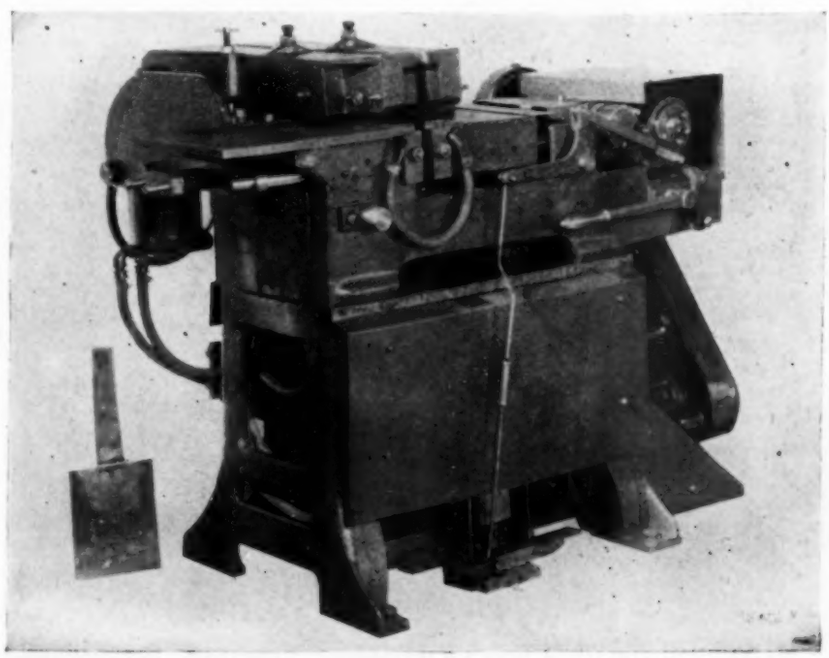
Installment selling may, or may not, be as successful in the equipment field as it has been in the fields of transportation and household machinery, but before condemning it utterly, as some readers of Mr. Lewis' article in Vol. 70, No. 20, have done, let us make sure that the condemnation is not based solely on the fact that installment selling is contrary to established custom.

MATERIALS PARTS · AND · EQUIPMENT

Thomson Special No. 12 Motor-Driven Butt Welder

EQUIPPED with special air-operated clamps and holding devices for welding back-straps to shovel blades, a special No. 12 motor-driven butt welder has been developed by the Thomson Electric Welding Company, Lynn, Mass. The welder has a transformer rated at 60 kva., of the water-cooled type. The right, or moving, platen is mounted on round side rods which slide in bearings at the right and left ends of the frame, and which are fully protected from flash. The clamps are air-operated and of the direct-acting type. Each half of the clamp carries two bearings which are bronzed-bushed. The jaws are of a special self-adjusting, rocking type assuring parallel clamping on the work. The platen push-up movement is obtained from a gear reduction unit driven by a 1 hp. motor through a belt. The cam in the mechanism can be shaped to obtain the proper flashing and push-up speeds.

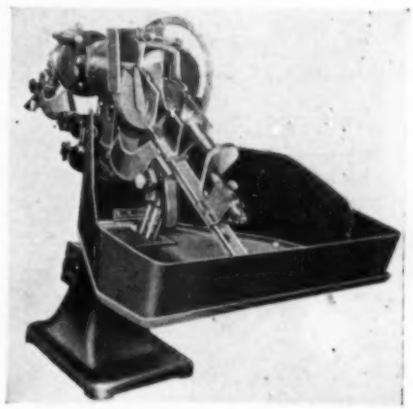
An adjustable time-cam switch is supplied and the return of the right, or moving, platen to open or loading position is obtained automatically upon the release of the clamping pressure. After the work has been clamped and the operator has depressed the foot lever the cycle of the welder is automatic. The machine is suitable for a wide range of flat strips or other shapes of bar stock by the application of suitable clamping dies and jaws. On the welding of back-straps to shovel blades the machine makes 300 welds per hour.



Thomson No. 12 Motor-Driven Butt Welder arranged for welding back-straps onto shovel blades

Gallmeyer & Livingston Drill Grinder

A drill grinder of the double holder type with a maximum capacity of 5 in. has been announced by the Gallmeyer & Livingston Company, Grand Rapids, Mich. The machine is suitable for grinding drills from No. 52 up to 5 in., and is believed by the manufacturers to be the largest size ever made. Both holders are of the non-calipering type on which it is possible to change from sharpening one size drill to another without preliminary adjustments. It is also possible to change from grinding a straight shank drill to a taper shank drill, and from a two-lip drill to a four-lip drill without preliminary adjustments.



Gallmeyer & Livingston Drill Grinder

The smaller drills are ground dry on a fine grain wheel on one side of the machine, and the large drills are ground wet on a coarse wheel on the other side of the machine. A 1½-hp. motor is built into the head as an integral part. The equipment includes grinding wheels, wheel guards, pump, tank, pan, and splash guards for the large holder side of machine, and a patented wheel trueing mechanism.

General Electric Insulating and Oil-Protection Lacquers

A series of lacquers in colors for use where an oil-resistant, highly-protective, durable and flexible insulating coating is demanded, has been placed on the market by the General Electric Company, Schenectady, N. Y. The base used in these lacquers is an alkyd resin produced from phthalic anhydride and glycerine and marketed by the company under the trade name of "Glyptal." These lacquers will adhere to galvanized iron and aluminum and serve as protection against rust. They are easily applied, are not affected by high temperatures as much as ordinary paint, and also have a dielectric strength greater than paint.

The lacquers are available in five colors: red, blue, brown, green and

aluminum. They may be applied by brushing, spraying or dipping, and will dry in about 30 min., dust-free, and in approximately 10 hours to a hard, smooth finish which is not brittle and which is easily cleaned. When using Glyptal lacquers no priming or sizing is necessary.

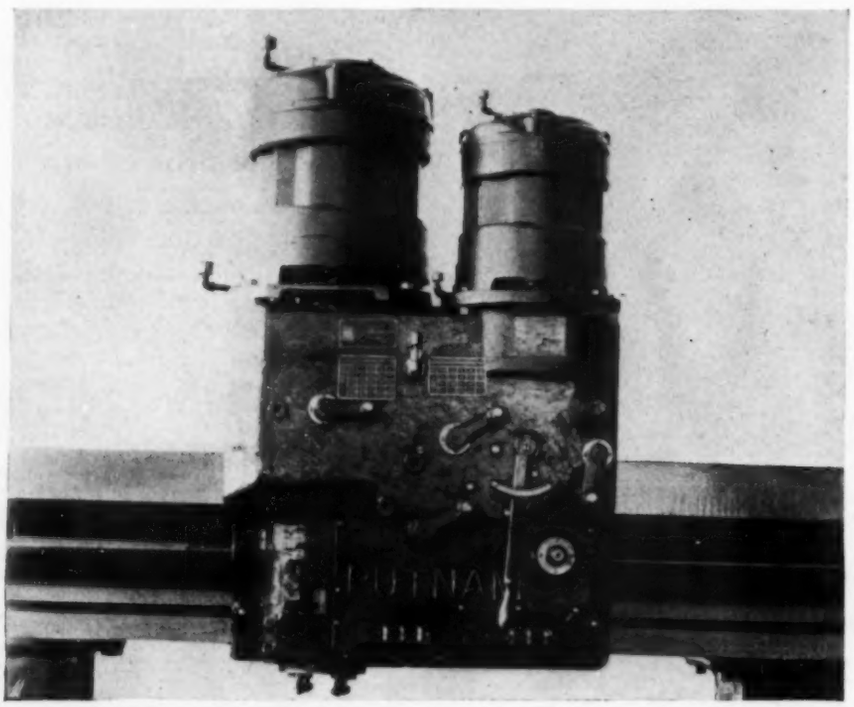
All Glyptal lacquers have basically the same characteristics. The No. 1201 red lacquer, however, is recommended for sealing joints against oil, water and gas leaks. It adheres strongly to metals, protecting them against corrosion, has a pleasing appearance and high dielectric strength. It is superior to the G-E No. 880 red protective paint.

Blue, brown and green Glyptal lacquers, Nos. 1206, 1210 and 1211, respectively, are primarily for finishing purposes. Aluminum Glyptal lacquer No. 1212, withstands extremely high temperatures, and tests show that discoloration is practically imperceptable at 600 deg. Fahrenheit. This lacquer is of a light-reflecting color, and has been used advantageously to brighten poorly-lighted shops. The lacquers are available in half-pint, pint, quart, one and five-gal. cans, and 52-gal. drums.

Putnam 4¾-Inch Unit Milling Head

A FOUR and three-fourths-inch unit milling head, which can be applied to all standard planer-type and rotary milling machines in either a vertical or horizontal position, as well as nearly all special design and single-purpose milling machines, has been placed on the market by the Putnam Machine Works, Division of Manning, Maxwell & Moore, Inc., Fitchburg, Mass. This head is a self-contained milling spindle saddle having incorporated in it all the mechanisms required for rotating the spindle at a number of speeds, for fast traversing the head itself in both directions along its guide, and for moving the spindle quill in and out. It may be designed with a large number of spindle speeds and feeds, or with a limited number to suit the given requirements. High efficiency in power consumption is due to the comparatively few and short shafts from the motor to the spindle and from the motor to the feed screw, or the spindle quill.

The unit head is of box construction with an oiltight milling spindle saddle having two motors mounted upon it. One motor is for driving the spindle and the other is for feeding the spindle and fast traversing the head or spindle quill. The spindle driving gearing is of the helical type, mounted on heavy shafts running in Timken tapered roller bearings. The spindle motor has four speeds and there are four mechanical changes available, thus giving an overall range of sixteen spindle feeds from 12½ to 250 r.p.m. in both directions in approximately a geometrical progression.



Putnam 4¾-Inch Unit Milling Head which is suitable for application to all standard planer type and rotary milling machines, as well as to some special design and single-purpose types

The unit head may be clamped in a fixed position on its guide and the spindle quill may also be clamped in the required position by means of a scale and adjustable pointer. Both the head and the spindle quill have hand adjustments, as well as power feed and fast traverse. The head fuels range from 1 to 12 in. per min. in twelve steps.

Two Types of Control Available

Motors may be furnished with two types of controlling apparatus. The first is a manual control, and the speed of the motor is set by a controller placed at the side of the machine. The motor is started and stopped by a push-button station on the head. The feed and fast traverse motor is furnished with a push-button station giving both forward and reverse movements. The second type of control is automatic in operation, the speed of the motor being set by a selector on the head, and the motor started, stopped and reversed by a push-botton station on the head.

The spindle has a No. 13 B. & S. tapered hole with a draw rod for cutter shanks. It has a 1-in. key across the end and four ⅝-in. tapped holes for clamping cutters to the nose. The spindle quill has a 10-in. travel in and out. The quill feeds are from 0.4 to 4.8 in. per min. in both directions in twelve changes in geometrical progression.

The spindle is driven by a 7½-hp., multi-speed a.c. motor. The speeds are 600, 900, 1,200, and 1,800 r.p.m. A d.c. motor may be furnished with the speed adjustable from 650 to 1,950 r.p.m. The 3-hp., multi-speed feed and fast traverse motor has speeds of 600, 900, 1,200 and 1,800

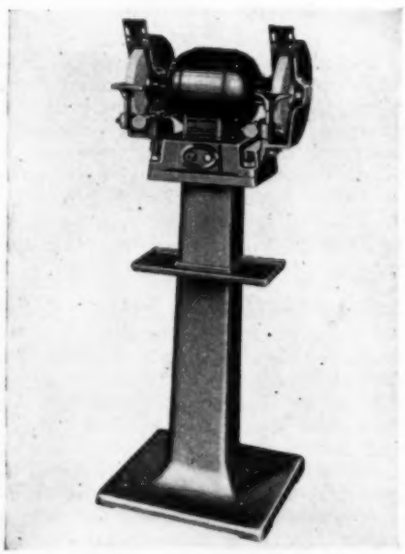
r.p.m. when ordered for a.c. circuits, and the d.c. machine has the speed adjustable from 700 to 2,100 r.p.m. Both motors are of the vertical type and have special characteristics.

Hill-Curtis 6- and 8-Inch Floorstand Grinders

Bench and pedestal type grinders carrying 6- and 8-in. wheels have been placed on the market by the Hill-Curtis Company, Kalamazoo, Mich. Both models are available with either a.c. or d.c. motors of standard specifications. Over-size ball bearings are mounted in the end head in close proximity to the wheels, and all bearings are tightly inclosed and protected from dust and grit. Likewise the motor itself is completely covered so that the danger to windings from an accumulation of dust is done away with.

Control of the grinders is supported by a two-pole quick make and break switch. Wheel guards and tool rests are adjustable to the wear of the wheels and can be removed quickly when the work in hand does not permit their use.

Single-phase, a.c. machines are



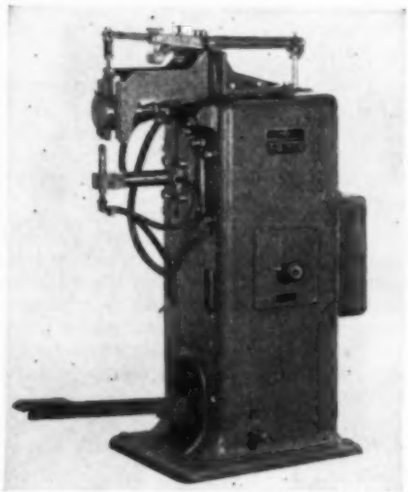
Hill-Curtis Floorstand Grinder which is being made in two sizes

equipped with an improved commutating-type repulsion-induction motor having low starting current characteristics so that the machine can be plugged into a lighting circuit outlet. Thus special wiring is unnecessary.

Thomson Series 180 Spot Welder

Whereas the conventional type of light-duty, foot-operated spot welder is equipped with a rocking upper horn or arm, this special unit is equipped with a vertical movement of the upper electrode. This feature is particularly desirable on high-speed welding of light parts which are to be fed automatically to the welding machine, and where it is necessary that all moving parts be as light as possible to obtain this high-speed operation without a hammering effect on the welding electrodes or dies. The unit has been placed on the market by the Thomson Electric Welding Company, Lynn, Mass.

The welder is also equipped with a multiple-pointed electrode which is desirable from the standpoint of die upkeep, particularly if the electrodes must be small, which means fairly rapid wear and frequent replacement if a single electrode is used. The resulting apparatus is suitable for making several hundred welds per minute on light sheet metal



Thomson Series 180 Welder equipped with a multiple-pointed electrode having vertical movement

parts fed automatically to the dies. Each upper electrode is indexed automatically to the proper position for welding during the upstroke of the upper slide. The power drive attachment on the machine illustrated has been left off because the unit was one of a battery being driven by a single power unit.

REVIEW : OF · RECENT · PATENTS

Relating to the Machinery and Metal Products Industries

Metal Working Machinery

An electroplating machine covered by patent 1,715,357, assigned to Hanson-Van Winkle-Munning Co., has a cathode carrier with shafts on which are mounted flanged wheels adapted to ride on rails and also to catch oil drip from journals.

The Heald Machine Co. has been assigned patent 1,715,550 for a grinding machine which incorporates a magazine and a carrier plate to transfer the pieces to be ground from the magazine into the grinding position.

Patent 1,715,606, assigned to the Bethlehem Steel Co., covers an assembling machine designed to hold bolts and nuts in proper alignment and to screw the nut on the bolt, which then is ejected.

Another patent, 1,715,936, assigned to the same company, deals with an extrusion press having a cylinder built up in such a way that heating or cooling liquid may be circulated circumferentially through an annular jacket space.

A paint removing or cleaning device for cylindrical articles and containers is covered by patent 1,716,165 assigned to the Liquid Carbonic Corporation. The cylinders, placed on an incline leading into the bath, force others up a lower incline out of the bath. The rate of discharge depends upon the variable angle of the second incline.

A strip-metal finishing machine was patented, 1,710,941, and assigned to the Wallace Barnes Co. It has a self-aligning toolholder carrying abrasive tools and means of oscillating these holders independently of each other.

A grinding and polishing machine patent, 1,711,015, assigned to the General Motors Corporation covers a motor mounted on a bracket with a rotating table on the top of the bracket driven directly by the motor.

The Norton Co. was assigned patent 1,711,061, on a crankshaft lapping machine having means for rotating and reciprocating the crankshaft while the pins are engaged with the laps.

A soaking-pit type of furnace patented, 1,711,273, and assigned to the Surface Combustion Co., Inc., has a

heating chamber in the form of a pit with a combustion chamber on each side of the pit.

A wire-cutting machine was patented, 1,711,277, and assigned to the F. B. Shuster Co. The wire is moved on a rest by a pivot, and the cutter severs the wire automatically and drops the parts into a box.

Frederick Clark and Albert V. Sullivan of Almeda, Calif., were granted patent 1,716,115 for a balanced-frame milling machine arranged to reproduce cams from a master cam. The frame oscillates relative to a fixed cutter while the speed is determined by the position of the cutter relative to the spindle.

Parts and Mechanism

Patent 1,711,151 was issued to John C. Lincoln, of East Cleveland, Ohio, on a method of arc welding, which consists in placing over the work an apparatus that excludes the air from the joint to be welded.

An oil-hole cover patented, 1,711,230, and assigned to Judson L. Thomson Manufacturing Co., has a hemispherical hollow head with a projecting shank which slides down into the tube leading to the shaft to be oiled.

The Consolidated Machine Tool Corporation of America was assigned patent 1,702,856 on a bending machine in which the rolls are driven by a motor, which drives through a worm and gear reduction.

The Kearney & Trecker Corporation was assigned patent 1,710,913 on a complete drive system for a milling machine which includes a main drive and reverser, and a means to maintain automatically the single direction of rotation regardless of the direction of rotation of the spindle.

The Brown Company has been assigned patent 1,715,376 covering a furnace electrode with a gasproof nonconducting and heat-insulating packing.

A shifter and control mechanism for machine tools, patent 1,715,488, assigned to Kearney & Trecker Corporation, has several rate-changing elements and a selector arranged to move the shifters as desired.

A reversing gear for tapping machines is the subject of patent 1,715,637 issued to Josef Brandstetter of Chicago, Ill. This device has a cup-shaped driving member which engages a friction wheel on the tap spindle.

To the Wayne Pump Co. has been assigned patent 1,716,096 which deals with a conical adjustable glare shield for fastening to a welding tool. The cone has a connection for exhausting fumes and a window through which the operator can see the work as desired.

Patent 1,716,129, assigned to The Cincinnati Shaper Co., covers a tilting work table arranged for rotatable adjustment and having a novel combination of elements for supporting the work.

Frank L. Cone of Windsor, Vt., has been allowed patent 1,716,303 on a tool carriage for automatic screw machines adapted to carry two separate tools for simultaneous operations on different pieces of work carried by the several spindles of a turret.

The Sterling Grinding Wheel Co. was assigned patent 1,714,754 on a sectional grinding wheel formed of a series of interfitting segmental blocks having adapter bearings between the blocks.

A patent, 1,714,568, on a removable bearing was assigned to the Long & Allstatter Co. It includes a housing having a recessed aperture with axially-split bushing supported in the aperture.

Materials

Patent 1,715,589 covering a rust loosening compound containing about 55 per cent tetrachlorethane, 35 per cent varnolene and 10 per cent kerosene has been issued to Frank M. Boynton of Philadelphia, Pa.

Three patents, 1,715,646-7-8, assigned to the Western Electric Co. and Bell Telephone Laboratories, Inc., deal with magnetic materials containing two or more of the elements iron, nickel and cobalt in different proportions to give desired magnetic qualities.

A process for removing rust and scale from ferrous materials or parts has been patented by William H. Cole of Paris, France (1,715,695). It involves treatment with phosphoric acid so dilute that no coating is left on the article subjected to the process. The treatment is carried out in a closed vessel at boiling temperature and under a pressure above atmosphere.

Ferro-vanadium containing about 85 to 95 per cent of vanadium is covered by patent 1,715,867 assigned to the Vanadium Corporation of America.

A process for making low-carbon chromium steel is the subject of patent 1,715,979 assigned to the Bethlehem Steel Co. The process involves adding a reducing agent to the slag to produce a strongly exothermic reaction, and pouring the alloy while the effects of this reaction are still present in the slag.

A nickel-molybdenum-iron alloy was patented, 1,710,445, and assigned to the Electro Metallurgical Co. It contains at least 40 per cent of nickel, 15 to 40 per cent of molybdenum, and not less than 10 per cent of iron.

A phenol-formaldehyde molding resin patented, 1,710,722, and assigned to the Economy Fuse & Manufacturing Co., is produced by heat-treating the phenol and formaldehyde in the presence of furfuramide.

TRADE PUBLICATIONS

DIES, WASHER. The Detroit Stamping Co., 3445 West Fort St., Detroit, Mich., has published General Folder No. 13 listing its combination dies for making flat and concentric washers, also gang washer dies and round dies. Spacers for milling machine arbors are also mentioned.

PINIONS, RAWHIDE. The Chicago Rawhide Manufacturing Co., 1301 Elston Ave., Chicago, Ill., has published a booklet giving the specifications and available sizes of rawhide pinions and gears. Various engineering data are appended. The bulletin contains 56, 9x6-in. pages.

ENGINEERING INDEX, 1928. The American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y., has published The Engineering Index for 1928 in two volumes. It is an encyclopedic bibliography of periodical engineering literature with an author index. The price of the two volumes is $110.

ENGINEERING PUBLICATIONS. The Engineering Experiment Station Committee, Association of Land-Grant Colleges and Universities, has prepared a summary of engineering research at the land-grant colleges and universities for 1929. Among other data, it contains the titles of publications, and the bulletins and circulars issued, together with research projects to be carried out.

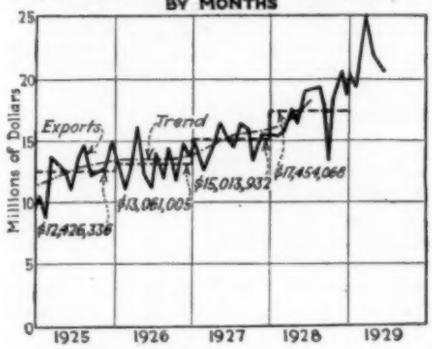
LABOR LEGISLATION. The U. S. Department of Labor, Bureau of Labor Statistics, has published Bulletin No. 486 on "Labor Legislation of 1928." The subject matter is divided into two parts, the first being entitled "Digest and Summaries of Certain Classes of Laws Affecting Labor," which is of general interest to labor, and the second part entitled "Text and Abridgment of Labor Laws," containing laws which more directly affect labor. The laws in Part I are classified under appropriate subject headings, while those of Part II are found under state headings. The cumulative index provides a ready reference to the laws found in this bulletin as well as those published in the preceding bulletins. The booklet contains 53, 9x6-in. pages and a list of other publications by the bureau. It may be obtained for 10 cents.

NEWS
OF THE WEEK

Five Months' Industrial Machinery Exports Show Substantial Gains

EXPORTS of industrial machinery from the United States during the month of May, totaling $20,887,000, were substantially in excess of those for the corresponding month of the previous year, according to a report prepared by L. J. Cochrane of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, but showed a decline of $1,409,000 under April 1929, and of $4,164,000 under the high record reached in the month of March. The downward trend indicated has no particular significance, however, since

EXPORTS OF INDUSTRIAL MACHINERY BY MONTHS



such fluctuations are to be expected and the general movement is upward. Of greater interest, as covering a longer period, is the fact that exports of industrial machinery for the first five months of 1929 totaled over $110,000,000 exceeding those for the same period of 1928 by $26,023,000. Thus, added impetus is given to the steady upward march of American industrial machinery exports, which has been one of the outstanding features of the trade for the last seven years.

Among the principal items, exports of well and refinery machinery showed the most striking gains during the first five months of 1929, as compared with the same period of 1928. Metal working machinery, however, was a close second, and notable increases occurred for internal combustion engines, mining and quarrying machinery, power pumps and construction and conveying machinery. Lesser gains were registered by textile, sewing and shoe machinery, and water wheels and water turbines was the only item which showed a decline.

The steady growth in exports of well and refinery machinery, which has been especially evident during the past year, was maintained during the first five months of 1929, foreign shipments of this item being nearly double those for the same period of 1928. Oilwell drilling apparatus figured prominently in this increase, but the chief gains were registered by other oil well and oil refining machinery, exports of which nearly tripled.

The sharp increase in the demand for American metal-working machinery is indicated by the fact that exports for the first five months of 1929 rose by almost $5,000,000 over the same period of last year. In the case of lathes, knee- and column-type milling machines, internal grinding machines, forging machinery and pneumatic portable tools, there were some especially notable gains, and foreign shipments of vertical boring and chucking machines, sheet and plate metal-working machines, rolling-mill machinery and foundry and molding equipment approximately doubled.

Power Equipment Exports Doubled

Among the various classes of power generating machinery, exports of steam boilers and stationary and portable internal-combustion engines over 10 hp., except Diesel and semi-Diesel engines and gasoline locomotives, more than doubled. Moreover, the latter two items showed substantial gains, as did also marine engines, engine accessories and parts, and steam specialties, foreign sales of the last named item exceeding $1,317,000, as compared with $704,032 during the January-May period of 1928.

Exports of construction and conveying machinery rose by nearly $1,500,000 over the first five months of 1928. This was caused by sharply increased shipments of concrete mixers, miscellaneous road making equipment, cranes, hoists derricks and elevators, although a slight falling off is to be noted in foreign sales of road rollers bucket, chain and belt conveyors and excavators and power shovels. The last named, however, far exceeded any other item in volume, exports for the first five months of 1929, totalling over $3,000,000.

In the mining and quarrying group, coal cutters were the only item which did not show a substantial increase, and, in the case of mine hoists and derricks, exports more than doubled over the first five months of last year, while deliveries of ore-crushing and sorting machinery reached a total of over $1,600,000 as compared with $1,150,000 during the January-May period of 1928.

American pumping machinery continues to be in large demand abroad and exports of this item from January to May, inclusive, 1929, exceeded those for last year by $1,300,000. Foreign sales of centrifugal pumps and reciprocating steam pumps more than doubled, while those of rotary pumps, although small in volume, were more than four times greater than last year.

In the miscellaneous group, which covers a wide range of machinery not separately classified, there were marked increases for such items as tobacco machinery, woodworking machinery, ball and roller bearings and parts, air compressors and paint sprayers.

* * *

Germany's 1928 Machinery Output Exceeds 1913

The value of Germany's machinery output for 1928 is officially stated to have been 4,000,000,000 marks, as against 3,400,000,000 in 1927. Home sales last year are reported as having reached 2,830,000,000 marks against 2,440,000,000 the preceding year. Exports, including reparations deliveries, were 1,170,000,000 marks, as against 960,000,000 the year before. Allowing for the 41 per cent rise in prices since 1913, production of machinery in 1928 exceeded that of 1913.

* * *

Propose Freight Change on Steel Articles

A new mileage scale of rates on iron and steel articles throughout official classification territory has been prescribed by the Interstate Commerce Commission. The Commission's report and order is the result of a general investigation of freight rates on iron and steel made in response to the Hoch-Smith resolution in which Congress declared that the lowest possible lawful rates compatible with the maintenance of adequate transportation service should be established on agricultural products, and that rates on other products should be adjusted in the light of prevailing conditions. The basic scale of rates prescribed by the Commission will re-

duce railroad revenues on the iron and steel traffic by $2,500,000 according to an estimate by one of the members of the Commission. Official classification embraces the territory east of the Mississippi and north of the Ohio and Potomac rivers.

The record contains a considerable amount of evidence intended to prove that the general level of steel rates is too high, but also indicates clearly, according to the Commission, that the level of the rates is of less importance than their relationship.

* * * *

Ford's European Cost of Living Inquiry Arouses French Reaction

By Our Paris Correspondent

THE request made of the International Labor Office of the League of Nations, at Geneva, by the Ford Motor Co. of England, for information on labor's wage and the cost of living in European centers where the new Ford production plants are to be established, has caused some pangs of suspicion in France. The fear appears to be that this is the final step in the American industrial invasion and the Americanization of Europe, and that this imminence is the natural result of the digging-in, or campaign of position, which has been going on since the war.

The International Labor Office has for some time been engaged on a summary investigation of what the real relation of the workman's wage to the cost of living may be throughout the world. The yardstick by which this comparison is measured is the basket of provisions. Food values are, after all, the principal factors that are recognized as something fundamentally necessary and understood of all peoples. Doubtless it was something of this kind that Mr. Ford had in mind when the request was made for a documentation which would enable a scale of values to be established, as far as the respective local conditions would permit, which should present wages and the bread basket, so to speak, lined up relatively throughout the world.

Fund Offered for Study

The reaction to the request, and Mr. Filene's generous offer to furnish a fund of $25,000 for such an investigation, seems to be that the League of Nations organization, of which the United States is not even a part, is to work on behalf of American "interests." This attitude, however, ignores the fact that this same publicly acquired and publicly distributed information is to be made available to all who may be interested, to take advantage of if they will, or, as the French theme puts it, if they *can*, which is mostly taken to mean that no one but Americans are in a position to take advantage of it.

As Mr. Filene's letter to the secretary of the League of Nations puts it: "This information is desired not only by Mr. Ford, but any employer of labor may find in it that aid and possible solution to many of the economic and industrial problems of today." Geography or nationality have no special rôles in the plan.

Mr. Filene states that this money is at first to be supplied by the Twentieth Century Fund, under his personal guarantee of payment. That American industries, particularly the metal-working trades, have doubled pre-war wages, and at the same time reduced the prices of the manufactured product, would seem to endorse the worth of at least an investigation to see if the same might not be possible in European production centers, whether the experience is to be carried out by an invading American enterprise, or some old, established European industry.

French Attitude Skeptical

France, at any rate, among the producing countries of old Europe, still reserves its attitude of skepticism toward the balancing of the wage and living elements as being a sure signpost to prosperity, stating once again that the European workman is often an artist in his profession, and not a mere pair of hands, and that he works for love and not for money. This, in its wide interpretation, may be taken to mean that the employer of labor is willing to make high-priced goods, take the benefits that his resulting small market affords, and pay his workers accordingly. Even a middle-of-the-road policy is not envisaged in many cases. Summing up the French attitude, we arrive at the conclusion that it stands pat on conservatism, and holds to its traditional reserve as to whether the benefits which might accrue from what are called "American methods" would really be beneficial to the mass of the population. To proceed on this basis, says one French comment, would be to set too rapid a pace toward a goal which, however desirable it might be for America with its vast natural resources and its equally vast home market, would doubtless never get into a real gait here.

It is suggested that, in spite of a considerable emigration of Europeans to America, there are still 200 million people left in Europe who have no intention of emigrating, or even being inoculated with the American virus. This statement indicates that public opinion in Europe, and in France in particular, favors the *laissez aller* policies which are doing so little to help the wage earner to improve his material conditions of life. Personal initiative, it is claimed, can never be drowned out by forming mass production minds.

A writer in a famous Paris "journal of opinion," goes so far as to state that "French industry, in the actual state of things as they exist, will be heading straight for ruin if it seeks to set and keep the pace of America in the matter of wages in relation to the cost of living." The attitude is seemingly inexplicable, but it is quoted for what it is worth, and it is within reasonable bounds to say that the whole question is, in the main, regarded in much the same light by the bulk of the leaders of modern industry in France.

Quoting from *La Journee Industrielle*, the whole question is in the interest of the benefits which American industries, especially those companies possessing foreign manufacturing plants, may achieve from the marshalling of these economic facts of the relation of wages and the bread basket, rather than any philanthropic desire that such an inquiry shall be of equal benefit to European industries. In other words, it would seem as though European industry thought itself not ready for a change. Industry, as such, may not be, in many cases, but the worker has his own ideas.

* * *

S. A. Hale Becomes Editor of *Coal Age*

S. A. HALE, who has been on the staff of *Coal Age*, a McGraw-Hill paper, since January, 1925, and who has been managing editor of that publication since January, 1928, has been appointed editor of the paper. He has for some time been in charge of the editorial activities. Mr. Hale brings to his new position the experience of many

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years of editorial work, beginning in 1906 on the *Chicago Daily News*, then successively to an associate editorship of *Traffic World*, the *Daily Traffic World and Bulletin*, western representative of the *Coal Trade Journal*, and later as editor of the same paper. He assumed his new duties on July first.

Former Assistant Secretary of Navy Joins McGraw-Hill

Will edit "Aviation" and also act as aeronautical counselor to other McGraw-Hill papers

EDWARD P. WARNER, who became editor of *Aviation* magazine on July 1, brings to his position the exceptional fund of knowledge and experience of a man long associated with aeronautics in its varied forms. In addition to his services as an editor, he will have a broader relationship with McGraw-Hill as counselor in aeronautical subjects, more specifically within the editorial fields of other publications of this company.

Mr. Warner has had a distinguished career in the aeronautical industry, extending over a long period of time, and

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embracing a variety of activities and relationships, including those of Assistant Secretary of the Navy for Aeronautics, Professor of Aeronautical Engineering at the Massachusetts Institute of Technology, and as author of a number of papers and books. His interest as a student of aviation dates from 1910, when he began building and experimenting with gliders. He is the holder of the medal of the Aero Club of France, which was awarded for the best technical work on aeronautical engineering for 1927.

Since Mr. Warner's appointment has been announced, a number of men prominent in the field have expressed their gratification at his selection for the work. Among the comments received are included those from F. Trubee Davison, Assistant Secretary of War; John H. Trumbull, Governor of Connecticut; David S. Ingalls, Assistant Secretary of the Navy for Aeronautics; Rear Admiral W. A. Moffett, Chief of the Bureau of Aeronautics, United States Navy, all testifying to his unusual ability and attainments, and predicting success for his editorship of the magazine.

Concurrently with Mr. Warner's appointment, a new policy was adopted by *Aviation*, that of co-operating with the other McGraw-Hill publications in adapting the new opportunities offered by aircraft to the uses of industry.

Mr. Warner was last week nominated as president of the Society of Automotive Engineers at the annual convention, held this year at Saranac Inn, New York. Nomination is tantamount to election. The mail vote is taken on constitutional amendments and nominations immediately after the convention.

Aviation is the oldest weekly in America devoted to the aviation industry. It was recently acquired by the McGraw-Hill organization, and since that time has undergone a number of changes. Earl D. Osborn, former publisher and editor, will continue his relationship with the magazine as contributing editor. He will travel in Europe this summer and will report for the magazine his observations of progress and activities in the field of aeronautics abroad.

* * *

Adopts Group Insurance

The Edlund Machinery Co., Inc., Cortland, N. Y., has provided its employees with group life, health and non-occupational accident insurance, on a co-operative basis whereby employer and employee share the cost. The plan calls for $1,000 life insurance, and sick and accident benefits of $10 a week. Employees suffering complete disability before age 60 will receive the full amount of the life insurance, with interest, in monthly installments.

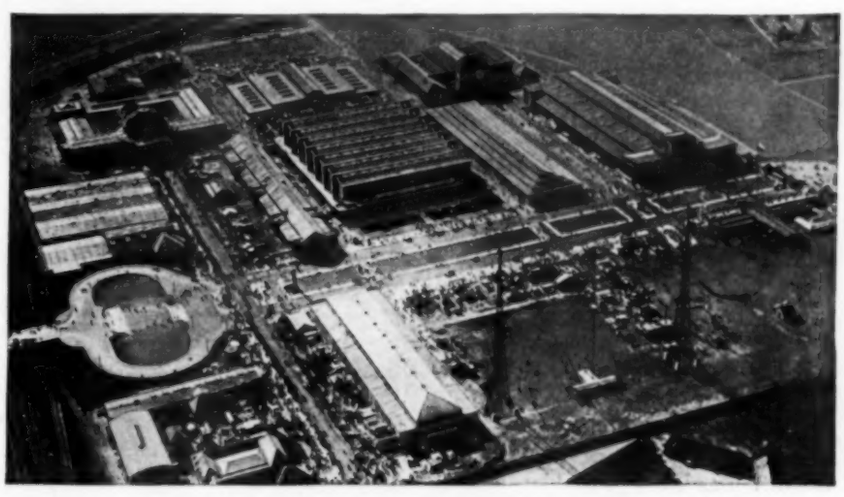
* * * *

Leipzig Fair Reopens August 25 with Large Machine Exhibits

THE Leipzig Trade Fair, to be held, August 25 to 31, is expected to attract more than 180,000 exhibitors and buyers from all parts of the world. The fair which is observed both in the spring and in the fall, is approaching its 700th anniversary, and outclasses all other industrial exchanges in size and volume of business transacted. These two annual fairs are regularly attended by more than 3,000 buyers from all sections of the United States.

America's expanding world trade is indicated this year by its participation both as exhibitor and purchaser at Leipzig. At the spring fair more than $400,000,000 worth of business was transacted by foreign visitors, America being the second largest. The United States sent more than 100 significant exhibits of its products, with highly satisfactory results.

The exhibits include the largest toy show in the world, a most important collection of musical instruments and accessories, the largest exhibit of textiles and textile machinery in Europe, metal products of all kinds, furniture, radio, and similar displays. In the accompanying illustration, the building at the rear center of the picture is devoted to electrical exhibits. Directly in front of it and to the right is the heavy machinery building, next the light machinery building and the automotive building. The heavy machinery building is the largest building of its type in the world. The automotive building is twice the size of Madison Square Garden.



Aerial view of Technical Fair Grounds at Leipzig

BUSINESS BAROMETER

Most American industries consider demand excellent only automotive output drops off

By THEODORE H. PRICE
Editor, Commerce and Finance, New York

IF THE worthy Bishop Heber were now alive, he would probably yield to the prevailing optimism by eliminating in his poetry his disparagement of those who disagreed with his theology, for it is to be doubted whether there was ever a time when people were as ready to believe that "whatever is, is best" as they are today.

This is true of political as well as economic conditions, and it is leading business men to put a favorable construction on almost everything that happens.

Thus 15 per cent for call money was interpreted as presaging an early decline in interest rates, and the New York Stock Exchange statement, which showed that its members were borrowing a record total of seven billion dollars at the end of June, was construed as a sign of financial strength because it is now argued that such enormous loans prove the existence of enormous resources.

Upon this theory stocks have moved up again; the grain markets are firmer, and the other commodity markets show a tendency to resist influences that normally have a depressing effect.

This is particularly true of cotton, which has yielded but slowly, despite an admitted improvement in the crop outlook, and the expectation that the government report will show that approximately fifty million acres have been planted to cotton in the United States this season

It is also possible that the relative strength of the grain and cotton markets may have been due to the moral effect of President Hoover's farm relief measure, and the appointment of his Farm Board, whose personnel is generally approved of by the members of the agricultural co-operative associations.

Confidence is now felt that some way to care for any temporary surplus of production will be found, and the fear of an acute or precipitate decline in any of the more important farm products seems to have passed.

This new-born confidence may foster commodity speculation, and it is a factor that should be carefully watched.

The cheerfulness that is so widespread and pervasive has been reflected in the distributive markets, and trade was remarkably active, considering the Independence Holiday.

All textiles have been in excellent demand and distinct improvement in the market for cotton goods is admitted. The same statement is true of most American industries, and the steel mills report a business that promises to keep them running at capacity until well into the autumn.

A slight reduction in the output of the automobile manufacturers is conceded, but sales and production continue to run ahead of last year, and the export demand is said to be remarkably good.

Another political factor that the far-sighted business man will consider is the tariff bill that Congress is chewing over during the recess that it is now enjoying.

The *New York Times* has printed several articles in which it is intimated that an advance in the tariff on industrial products will be opposed by a majority of both the Senate and the House, and that any changes that may be enacted must be distinctly in the interest of the farmers.

No one knows whether this view is correct or not, but the *quid nuncs* at Washington are prophesying that Congress will delay action until after it has heard from the people at the elections to be held in November. The delay may perhaps have a slightly unsettling effect upon business, although no one seems to pay much attention to such a possibility at present.

In Europe, as here, optimism prevails, although the altitudes of prosperity reached are much below those attained in America.

The opening session of the recently-elected British Parliament is generally regarded as auguring an improvement in economic conditions. The King and the English political leaders were, however, characteristically restrained in expressing themselves with regard to the many important matters upon which they will have to act.

No little disappointment is felt in the United States because there now seems to be some doubt as to whether Premier MacDonald can visit America this year.

On the Continent a general improvement in business seems to be in progress, and if the Labor Ministry is able to solve the problem of unemployment in Great Britain, a forward surge in business activity may soon be seen throughout the British Empire.

A notable improvement in the shipping business is reported, and much new tonnage has been contracted for by the British ship-builders.

This about completes an impressionistic picture of the business situation on this side of the Atlantic and overseas. The enthusiasm and prosperity that prevail have given an impetus to trade that will not soon be exhausted.

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From this page the reader will get a quick picture of current business and industry. The boxed material below is a summary of the letters from regional correspondents of the American Machinist, published in full on the opposite page.

JULY shows a slight let-down in the machine tool and machinery fields. No positive recession has occurred, however; some centers are unusually active, and a brisk fall business is anticipated.

CHICAGO sales in June were almost up to May. The first half of 1929 was 40 to 60 per cent better than the first half of 1928. Railroads, electrical and general industries are making purchases. Indianapolis shows a summer drop in the automotive industry, but railroads, and auto accessory, radio, radio cabinet and airplane manufacturers are doing some buying. Detroit had a successful June, with paper mills buying, a few large automotive orders given out, and the outlook promising. In Cincinnati, summer prospects are good, machine tool manufacturers are busy, but skilled labor is still scarce. The Southern district is active in the woodworking, textile and railroad fields, but contractors and small machine shops are doing little buying.

NEW YORK is still one of the relatively busiest centers, and July thus far promises to be a big month. Throughout New England the situation is spotty, with airplane plants most active. The Norton Co., Heald Co. and Hendey Machine Co. are building plant additions. In Canada, industrial concerns are expanding. Orders, such as for 140 box cars, and $1,000,000 worth of fabricated steel for a railroad bridge, have been placed, and the Toronto Transit Commission has recommended the awarding of a $1,500,000 order for cars and trailers to the National Steel Car Company.

THE INDUSTRIAL REVIEW

Weekly progress of the machinery and machine tool business

THE following reports, gathered from the various machinery and machine tool centers of the country, indicate the trend of business in these industries and what may be expected from the future:

INDIANAPOLIS

Business remains at a fair level in Indianapolis. The usual summer dull season has not materialized to the same extent it did last year. While there are some soft spots, most of the machinery and tool users in the state are well fortified with orders, and from present indications there will not be the dullness usually expected. Some industries are expecting rushing business.

During the last month, demand from the automobile factories has fallen down considerably. Production has been cut and these factories to a large extent are out of the market, since their new models have been perfected and put into production. The demand for special machinery to be used by accessory manufacturers, however, continues good. The same is true of the body trade, particularly commercial bodies and custom builders. A similar condition prevailed, however, last year.

Demand from the radio-cabinet manufacturers and the radio makers is good. The past year has seen these two industries develop in Indiana into very active consumers. No large extensions are being planned at the present time, but factories now in production are making replacements.

Railroad demand is only fair. With harvests coming on, the roads have put their rolling stock and motive power into the best shape possible, and will hesitate to withdraw any equipment from transportation during the harvest season, until absolutely necessary.

A good demand for small tools is coming from the garages and should continue for some time. Demand from the airplane industry also is reported good.

CINCINNATI

Due to the retarding influence of the national holiday, the volume of business booked by the machine tool manufacturers of the Cincinnati district in the past week was less than in the previous similar period. Orders have now begun to flow in freely, and with the majority of the concerns the sales have climbed to their former good level. While there are those who expect a midsummer lull, there are quite a few who expect the market to be fairly active in that period.

Selling agents report that, due to the holiday, their out-of-town men were taken off the road for a few days, and therefore their week's sales less than in the previous corresponding period. But the needs in local and adjacent territory are large, and sales should resume their former good level.

The week's orders came from all sections of the country, the great majority being from general machinists and miscellaneous users, whose requirements were single tools and replacements, well diversified as to sizes and types. A few scattering small orders were reported from railroads and concerns in the automotive field.

Compared to the previous week there was a reduced number of inquiries. This, of course, is attributed to the holiday and is not taken as a forecast of a market recession. At this time the inquiries are increasing in number and it is expected that the volume will be back to normal in the next few days. Those received were well scattered and well diversified.

Machine tool manufacturers are busy, taking the trade as a whole, as is shown by the fact that skilled mechanics have become so scarce that it is difficult to secure men of this type. According to a report of the Public Welfare Department, a little more than 94 per cent of the city's labor, skilled and unskilled, has steady employment.

NEW ENGLAND

Sales of machine tools in the New England territory during the current week were indicative of a spotty market, both as regards the kind of equipment sold and the sources of business. Outstanding transactions, though there were no large orders, favored speed lathes, grinding machines, and milling equipment. Airplane builders were again prominent in the machinery market, and were likewise well represented through purchases of additional airplane motors.

Distribution of machine tools to the automobile field continues to be a feature of New England production. New orders from this source, however, are scattered and have fallen off in numbers from week to week. Little or no business is being derived from New England railroads at the present time. Aside from these two sources, prospective business is bright, and beyond occasional weekly fluctuations, summer sales should proceed at a good level.

The used tool market has shown a more pronounced decline. Business is brisk only in spots, and the situation as a whole must be classified as dull.

The Norton Co., Worcester, is about to proceed with the construction of a third new unit which will be five stories high. The Heald Co., Worcester, Mass., and the Hendey Machine Co., Torrington, Conn., have large additions under construction also. Prospective sales of metal-working and woodworking equipment for manual training are developing at Meriden, Conn., Pawtucket, R. I., and Boston, Westfield, and New Bedford, Massachusetts.

CANADA

Prospects for the machinery and machine tool business in Canada during the second half of the current year appear particularly bright. Business generally throughout the country is at a higher peak than at the same time last year. Employment has never been more brisk. A relatively large program of railway construction has been entered upon, development of water power and mining resources is unabated, and factory facilities are being enlarged in nearly every province.

The outlook for car-building plants is very promising. The Toronto Transportation Commission has recommended to the City Council that 55 cars and 55 trailers be purchased from the National Steel Car Corporation. This contract will involve a sum in the neighborhood of $1,500,000. An order for 140 box cars has been received by the Eastern Car Co. from the Canadian Pacific Railway. This order is in addition to a contract for 500 cars received some time ago. The Canadian Car and Foundry Company's situation in the matter of orders on hand and in sight is distinctly favorable.

The Dominion Bridge Co. is now engaged in supplying steel for the Canadian Pacific Railway bridge over the Saskatchewan River at Nipawin, Saskatchewan, with about a million dollars worth of steel for the superstructure of this work.

Officials of the Waterloo Manufacturing Co. state that at the present time a steady production of seven machines daily is being maintained, as compared with an average of 3.6 machines in other years. One transaction which gave a further impetus to business was an order from the Cockshutt Plow Co. for a large number of threshers for Western Canada.

Production of automobiles showed a decline during May for the first time this year, after reaching a new high level in April. The output in May dropped to 31,559 cars, or 25 per cent below the record production of 41,901 cars in the preceding month.

DETROIT

June business in the machinery and machine tool field was spotty and irregular, but there is considerable evidence to indicate that the total sales compare favorably with the first five months of the year. Thus far it is too early to tell whether July will be a profitable month here, but some dealers report the receipt of a large number of inquiries, and many of the automobile manufacturers indicate that July and August will be much more active than these months usually are. The fact that this is vacation-time has an undeniable influence on sales totals, but, in spite of this fact, there is a bullish tendency that augurs well for the immediate future.

Dealers in specialized equipment have made a number of unusually large sales during June. One outstanding dealer already reports the receipt of several large orders for motors and equipment from one of the large automobile concerns. The foundries are spending more money than they have in the past few months, and a number of the small shops are expanding and buying new machinery and equipment.

Business in the automobile field has not been particularly good during the past six weeks but has been above the average for this time of year. There is a general feeling that it will improve by the end of the summer. A large number of sales have been made in other lines, particularly to the paper and steel industries. The paper mills are striving to cut their costs, being engaged in an intense price-cutting war that has robbed them of all profit for a good many months. They are spending money for labor-saving and cost-reducing machinery wherever they discover profitable opportunities.

Employment is lower than it has been at any time this year. General business conditions are very good.

CHICAGO

With the passing of June, the first indications of an actual recession in the machine tool business is reported. This applies particularly to sales, while inquiries having reference to future buying are keeping up in good volume. The consensus of opinion among the trade is to the effect that at least until September, a period of comparative inactivity will follow in the wake of the six months of prosperity that

has marked the course of the machine tool industry this year.

The June volume of business up to the last week of the month compared favorably with that of May, some concerns reporting a slight gain. As far as summaries for the first half of 1929 can be estimated at this time by manufacturers' representatives and distributors, they show a gain over the same period last year of anywhere from 40 to 60 per cent.

July starts with a lull in buying. Railroads continue to send in occasional inquiries for single tools and small lots, the Burlington, Northwestern and Santa Fe being among those still in the market. There has just been received from the Clinchfield Railroad Co., Erwin, Tenn., a list numbering seven tools, most of which are for heavy duty. General industry, and manufacturers of electrical equipment in the Chicago area, are creating the greater part of the business noted at this time.

SOUTHERN DISTRICT

Machinery and machine tool business in the southern district has shown a seasonal decline the past two weeks, and though sales compare favorably with the corresponding period last year, they were lower the last half of June than they were the first part of the month. Hence, as a whole, June showed a decline compared with May. Dealers do not look for any further decline in sales to speak of, but believe business will hold up fairly well through the summer.

There has been some improvement in the demand for woodworking machinery in the lumber and furniture field, and this business now is about on a par with the same period last year, though it continues below the normal level. Sales to the textile mills have showed a tendency to decline lately, but are still considerably better than at this time last season, while prospects are that they will continue so, since this industry is investing a larger sum than it ever has before in new mill and village erection in the group of southeastern states. Business also continues fairly good in the railroad field and some good sales of heavier equipment have been recently reported for shop building projects now under way, while the outlook is also promising for the next few weeks. Smaller machine shops and garages are still inactive in the market, placing a few orders for used or rebuilt equipment, but scarcely any orders for new machinery.

Some sales are still being reported of equipment to contractors in the larger centers, but, as a whole, this business is on the decline. A few sales are also being made to road builders, but they are also considerably less than they were a few weeks ago.

NEW YORK

The New York market for machine tools oponed strong in July. Most dealers and manufacturers' representatives report that inquiries and orders show no let-up, and that, whatever the effect of vacations and seasonal dullness in previous years, they have had no marked influence on demand during the present summer. The spirit of optimism is even more marked this week than during June. The month of June was a big one for most dealers, ending strong for many who had suffered a slowing up during its first two weeks.

As usual, the buying is not in large quantities and is not concentrated in a few industries. Airplane plants continue to make purchases, following a slight drop-off during the latter part of June. The railroads and electrical industries are likewise placing orders. Printing machinery manufacturers have come on the market for a few important items. The only two large lists out, Curtis-Caproni and Nichols Copper, are still open, and no reports of the closing of orders with any dealers have been issued.

Prices remain unchanged. The delivery situation, likewise, is unimproved. Machine tool manufacturers are rushed with orders and cannot make early shipments. The summer season is not helping to increase production.

All types of equipment seem to be in demand, and all manufacturers in the machine tool field are sharing in the good business. Used machinery is moving actively, because many purchasers cannot wait for deliveries on new equipment.

Sales of machines by the Triplex Machine Tool Co. for the past week include: One 3-ft. Fosdick radial drill, two Oesterlein grinders, one Oesterlein milling machine, one Ames bench lathe, two bench filing machines, two woodworking saws, two floor grinders, one floor speed lathe, and one engine lathe.

Business Items

The Austin Machinery Corporation of Michigan, and the West Michigan Steel Foundry Co., both of Muskegon, are being merged. Each company will operate as a separate division of the merged company and each plant will be enlarged in the near future. The Austin company manufactures trench excavators and backfilling machinery, cranes, and similar devices. The West Michigan Steel Co. produces electrical steel castings.

The Transmission Engineering Company has been formed at Philadelphia by L. H. Shingle and associates for the purpose of specializing in power transmission problems. The company intends to devote its entire time and energy to securing data on the most economical method of mechanically transmitting power. Their engineers will be available to any manufacturers who have a transmission problem.

The Despatch Oven Company, Minneapolis, Minn., manufacturers of industrial ovens, has appointed the Industrial Engineering & Equipment Company, 1341 Syndicate Trust Building, St. Louis, as sales representatives in southern Illinois and south-central Missouri. The Despatch Oven Company manufactures core and mold ovens, special drying ovens and conveyor ovens for high speed production.

The Keystone Steel & Wire Co., Peoria, Ill., and the Continental Steel Corporation, Kokomo, Ind., are negotiating a merger, according to a statement issued by D. P. Sommer, vice-president of the Keystone company. This combination, if consummated, would bring together companies with assets of more than $25,000,000.

Henry Disston and Sons, Inc., of Philadelphia, Pa., and the Wallingford Steel Co., of Wallingford, Conn., have recently been licensed to roll Nirosta steel into strip form by the Krupp Nirosta Co., Inc. Nirosta steel is a chrome-nickel steel developed by the Krupp Works at Essen, Germany.

The McCay Machine Company, Youngstown, Ohio, is planning on enlarging its present plant. The company manufactures machinery for automobile factories and sheet mills.

The Western Iron Stores Co., Milwaukee, Wis., has been appointed exclusive sales agent for the N. A. Strand line of flexible shaft equipment for the state of Wisconsin. After July 1, the company will have a stock of machines and equipment on hand.

The United Aircraft Corporation, East Hartford, Conn., is erecting a new plant to cost in the neighborhood of $2,000,000. When completed, the plant will be used for the manufacture of Pratt & Whitney engines and of Vought-Corsair airplanes.

The Multiple Aircraft Corporation of Waterbury, Conn., has recently been incorporated. The company intends to enter into the manufacture and sale of aircraft of all kinds, as well as to buy, lease, and license patents granted to the aircraft field.

The Napoleon Stamping Co., Napoleon, Ohio, has been purchased by C. O. Minger, president of the Electric Auto-Lite Co., Toledo, Ohio, and C. S. McIntyre, president of the Monroe Auto Equipment Co., Monroe, Mich., for their own accounts.

The Taylor Winfield Corporation, Warren, Ohio, manufacturers of welding machinery and devices, has opened a branch office at 2857 East Grand Boulevard, Detroit, Mich., in connection with the offices of its representatives, the Denton & Anderson Company.

The Union Chain & Mfg. Company, Sandusky, Ohio, has opened a sales office at 1535 Naomi St., Indianapolis, Ind., in charge of A. R. Young. The company has also opened a sales office at 3rd & Plum Sts., St. Louis, in charge of Hugh Scott.

The Kirk-Morrow Iron Works Co. was recently organized in Iola, Kan., to take over and operate the Iola plant of the United Iron Works Co. The plant will manufacture tanks and steel rigging equipment.

The Western Automatic Machine Screw Co., Cold-drawn Bar Steel Division, Elyria, Ohio, has appointed the Motor City Sales Co., 676 West Grand Boulevard, Detroit, as sales and service representative in Michigan.

The Diamond Machine Co. and the Builder's Iron Foundry, affiliated companies of Providence, R. I., have moved their Philadelphia (Pa.,) offices to 903 Elverson Building.

The Carboloy Co., Inc., 350 Madison Ave., New York, has opened a New England sales office at Bridgeport, Conn., in charge of H. R. Hayter, 515 City National Bank Building.

The Service Tool and Die Manufacturing Co., Chicago, has started work on a new factory building at 4627 West Fulton St., to have a floor space of 15,000 sq.ft.

The Motor Specialties Co., Muskegon, Mich., maker of camshafts for industrial engines and aircraft, has authorized a 50 per cent plant expansion.

Personals

H. R. SMALLMAN, for the past three years assistant to the sales manager of the Hanson-VanWinkle-Munning Co., Matawan, N. J., has been made manager of the Chicago office of the company, with headquarters at 549 W. Washington Blvd. H. M. CHERRY, who for the past seven years has represented the company in Michigan, has been made manager of the Detroit office of the company, with headquarters at 5415 Twelfth Street. LOUIS M. HAGUE, who for the past two years has represented the company in western Pennsylvania, has been made manager of the Pittsburgh-Cleveland office, with headquarters at 106 Liberty Ave., Pittsburgh, the territory comprising Ohio, Western Pennsylvania, and West Virginia.

E. J. CLOUTIER, who has been engineer in charge of production at the Graham-Paige Motors Corporation body plant at Wayne, Mich., since it was opened in January, 1928, was recently appointed chief body engineer, with offices at the main plant in Detroit. M. F. WEBBER, who has been with the company since 1924, has been promoted to the post of assistant body designer.

J. L. MOTT, who for many years was connected with the Mott Iron Works of New York, is president of the recently merged companies of Chas. Cory & Sons, Inc., and the Kings County Iron Works. The company has also recently purchased the Fairfield Ave. plant of the Stamford Rolling Mills, Stamford.

MERTON W. ZEMAN, sales manager, machine division, Osborn Manufacturing Co., Cleveland, recently returned from Europe, accompanied by William Rawlinson, managing director, J. W. Jackman & Co., London, who is on an inspection tour of American plants.

E. H. DAHLQUIST has been appointed sales manager for the Superior Universal Products Co., Bowling Green, Ohio, manufacturer of universal joints, radius rods, guide links and tie rods. Mr. Dahlquist was for many years with the Timken-Detroit Axle Co., Detroit, Mich.

LAWRENCE D. WEANING has become general manager at Birmingham, Ala., for the Reeves Bros. Co., Alliance, Ohio, plate fabricator. Mr. Weaning was formerly vice-president and general manager of the Variety Iron & Steel Works Co., Cleveland.

C. W. FISHER has been elected vice-president and general manager of the Austin Machinery Corporation, Muskegon, Mich. Mr. Fisher was formerly Chicago district sales manager for the McMyler-Interstate Company, Bedford, Ohio.

HUGO BILGRAM, president of the Bilgram Machine Works, Inc., of Philadelphia, Pa., an authority on gears and gear generation, was tendered a banquet on Saturday, June 29, at Philadelphia. Mr. Bilgram, who is in his 83rd year, is still active in his industry.

GRANVILLE P. ROGERS, who formerly was managing director of the Artistic Lighting Equipment Association, New York, is now managing director of the Steel Founders' Society of America, with offices at 932 Graybar Building, 420 Lexington Avenue, New York City.

J. P. ARMSTRONG, Balboa Bldg., San Francisco, has been appointed to take over the management of the Metal Stampings Contract Division (California) of the Geuder, Paeschke & Frey Co., Milwaukee, Wis.

CLARENCE A. EARL, formerly vice-president of the American Hardware Company, New Britain, Conn., was recently made president of the Charles Freshman Company, Chicago radio manufacturer.

DONALD K. WHITE, sales manager of the E. H. Jacobs Manufacturing Co., Danielson, Conn., was recently made vice-president in charge of sales of that company. The company manufactures textile loom equipment.

FREDERICK E. MOSKOVICS, Indianapolis, has been elected president of the Improved Products Corporation, New York. Mr. Moskovics was formerly president of the Stutz Motor Car Company of America.

LEONARD S. HORNER, president of the Niles-Bement-Pond Co., has recently been elected New England director of the United States Chamber of Commerce at the annual meeting, held in Washington.

E. M. HERR, former president of the Westinghouse Electric & Manufacturing Co. since 1911, who recently resigned to take an extended vacation, has been elected vice-chairman of the company.

R. L. SITTINGER, Boston, has been appointed representative of the American Fluid Motors Co., in the states of Maine, Massachusetts, Vermont, Rhode Island, and New Hampshire.

WM. H. COLLINS has been appointed general superintendent of the Goodyear-Zeppelin Corporation, Akron, Ohio, which is building two super-dirigibles for the United States Navy.

THOMAS B. BENNETT has been made secretary-treasurer of Carow-Liedgren, Inc., Muskegon, Mich. Mr. Bennett is also president of the Bennett Pumps Corporation, Muskegon Heights, Mich.

N. DAVID THOMPSON has recently been appointed director of sales of the Peck-Stow & Wilcox Co., Southington, Conn. The company manufactures tinners' tools and a line of hardware specialties.

W. T. HAGGARD, formerly sales manager in the Pittsburgh and Buffalo branches of the J. A. Fay & Egan Co., Cincinnati, has been appointed general sales manager for the company, with headquarters in Cincinnati. Mr. Haggard left on July 1 to visit branches of the company in cities on the Pacific Coast.

WILLIAM ROBBINS has been appointed district manager in charge of the Chicago office of the Chisholm-Moore Hoist Corporation, of Tonawanda, N. Y.

Obituaries

E. BYRON PIEPHO, who retired as vice-president of the St. Louis Can Co. on January 1, died on July 6 at Flushing, L. I. He had been in ill health for several months. He was 76 at the time of his death.

EDWARD L. FRISBIE, vice-president and director of the American Brass Co., Waterbury, Conn., died of heart disease at his home in Middlebury, on July 3. He was 74 years of age.

Forthcoming Meetings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Third national meeting of the Iron and Steel Division, during the Steel Treaters' Exposition, Cleveland, September 11-13. Calvin W. Rice, secretary, 29 West 39th St., New York City.

NATIONAL METAL CONGRESS. To be held in Cleveland September 9 to 13. Simultaneous meetings of the American Welding Society, the Institute of Metals Division, American Institute of Mining & Metallurgical Engineers, Iron & Steel Division, American Society of Mechanical Engineers, the Iron & Steel Division, A.I.M.E., and the American Society for Steel Treating. W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland, Ohio.

NATIONAL METAL EXPOSITION. Eleventh annual, held under the auspices of the American Society for Steel Treating, Cleveland Public Auditorium, Cleveland, Sept. 9-14. W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland.

MACHINE TOOL BUILDERS EXPOSITION. Under the auspices of the National Machine Tool Builders Association, Sept. 30 to Oct. 4, in the Public Auditorium, Cleveland, Ohio. Ernest F. DuBrul, general manager, 1415 Enquirer Bldg., 617 Vine St., Cincinnati.

MACHINE TOOL CONGRESS. In connection with the exposition of the National Machine Tool Builders' Association, to be held Sept. 30 to Oct. 4, in the Public Auditorium, Cleveland, Ohio, a national machine tool congress will be conducted under the joint leadership of the S.A.E. and the Machine Shop Practice Division of the A.S.M.E.

THE WEEKLY PRICE GUIDE . . .

Rise and Fall of the Market

NO recession from present high levels of steel production and demand is foreseen, despite nearness of mid-summer, the usual time for slowing down. Buying is heavy in steel pipe, plates, bars and sheets. The market is less active than a week ago, in structural steel shapes and iron for casting pipe, radiators and sanitary ware. Prices, with very few exceptions, are holding firmly to quoted levels. Light plates, blue annealed, No. 10 gage, advanced 15c. per 100 lb. during the week, to a maximum of $2.35, f. o. b., Pittsburgh mill. Linseed oil is up 0.2c. per lb. to 11.7c at New York.

(All Prices as of July 5, 1929)

IRON AND STEEL

PIG IRON—Per gross ton, f.o.b:

CINCINNATI	
No. 2 Southern (silicon 1.75@2.25)	$18.44
Northern Basic	20.89
Southern Ohio No. 2	21.19
NEW YORK—Tidewater Delivery	
Southern No. 2 (silicon 1.75@2.25)	20.75
BIRMINGHAM	
No. 2 Foundry (silicon 1.75@2.25)	15.00
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.76)	21.76
Virginia No. 2	24.79
Basic	20.76
CHICAGO	
No. 2 Foundry local (silicon 1.75@2.25)	20.00
No. 2 Foundry, Southern (silicon 1.75@2.25)	20.76
PITTSBURGH, including freight charge ($1.76) from Valley:	
No. 2 Foundry	19.76
Basic	19.26
Bessemer	21.26

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb:

Detroit	4.50
Cleveland	5.00
Cincinnati	4.50
New York	5.25
Chicago	4.50@4.75

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the mill base in large lots:

Blue Annealed*	Pittsburgh Mill Base	Chicago	Cleveland	New York
No. 10	2.20@2.35	3.35	3.25	3.90†
No. 12	2.25@2.40	3.45	3.30	3.95†
No. 14	2.35@2.50	3.55	3.35	4.00†
No. 16	2.45@2.60	3.65	3.45	4.10†
Black				
Nos. 18 to 20	2.65@2.75	3.85	3.70	3.80
No. 22	2.80@2.90	4.00	3.85	3.95
No. 24	2.85@2.95	4.05	3.90	4.00
No. 26	2.95@3.05	4.15	4.00	4.10
No. 28	3.10@3.20	4.75	4.15	4.25
Galvanized				
No. 10	2.80@2.90	4.20	4.05	4.05
Nos. 12 to 14	2.90@3.00	4.30	4.15	4.15
No. 16	3.00@3.10	4.40	4.25	4.25
No. 18	3.15@3.25	4.55	4.40	4.40
No. 20	3.30@3.40	4.70	4.60	4.55
No. 22	3.35@3.45	4.75	4.65	4.60
No. 24	3.60@3.70	4.90	4.75	4.75
No. 26	3.75@3.85	5.15	5.00	5.00
No. 28	4.00@4.10	5.40	5.25	5.25

*Light plates. †Up to 3,999 lb.

WELDED STEEL PIPE—Warehouse discounts are as follows

	New York		Cleveland		Chicago	
	Black	Galv.	Black	Galv.	Black	Galv.
1 to 3 in., butt welded	50%	36%	55½%	43½%	54%	41%
2½ to 6 in., lap welded	45%	32%	53½%	40½%	51%	38%

WROUGHT-STEEL PIPE LIST

Size, Inches	List Price per Foot	Diameter in Inches—External	Diameter in Inches—Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	.28

SEAMLESS STEEL TUBING—Following net prices are for seamless mechanical tubing, cold drawn, round, .10 to .30 carbon, at New York warehouse in lots of less than 100 ft. or 100 lb:

Thickness—Decimal Fractions	B.w.g. and	Outside Diameter in Inches—Price per Foot— ⅛	¼	⅜	½	⅝	¾	1	1⅛	1¼
.035"	20	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.23		
.049"	18	.17	.18	.19	.20	.21	.23	.25		
.065"	16	.19	.20	.21	.22	.23	.25	.27		
.083"	14	.20	.22	.23	.24	.25	.27	.29		
.095"	13	.21	.23	.25	.26	.27	.29	.31		
.109"	12	.22	.24	.26	.27	.28	.30	.32		
.120" or .125"	11	.23	.25	.27	.28	.29	.31	.33		
.134"	10	.24	.26	.28	.29	.30	.32	.34		

MISCELLANEOUS—Warehouse base prices in cents per lb:

	New York	Cleveland	Chicago
Spring steel, light*	4.50	4.65	4.65
Spring steel, heavier	4.00	4.00	4.00
Coppered Bessemer rods	6.05	6.00	6.20
Hoop steel	4.25†	4.00	4.15
Cold rolled strip steel	6.25	6.00	6.10
Floor plates	5.10†	5.30	5.00
Cold drawn, round or hexagon‡	3.50	3.65	3.60
Cold drawn, flat or square‡	4.00	4.15	4.10
Structural shapes	3.30†	3.00	3.10
Soft steel bars	3.25†	3.00	3.00
Soft steel bar shapes	3.25†	3.00	3.00
Soft steel bands	3.75†	3.65	3.65
Tank plates	3.30†	3.00	3.10
Bar iron (2.75 at mill)	3.24	3.00	3.00
Drill rod (from list)	60%	55%	50%

*Flat, ⅛-in. thick. †Up to 3,999 lb., ordered and released for shipment at one time. ‡Cold finished steel, shafting and screw stock.

Electric welding wire at New York warehouse—$\frac{3}{32}$, 8.35c. per lb.; ⅛, 7.85c. per lb.; $\frac{5}{32}$ to ½, 7.35c. per lb.

METALS

Warehouse Prices in Cents Per Pound for Small Lots:

Copper, electrolytic, New York			19.25
Tin, Straits, pigs, New York			47.50
Lead, pigs, E. St. Louis	6.80	New York	8.25
Zinc, slabs, E. St. Louis	6.80	New York	8.25

	New York	Cleveland	Chicago
Antimony, slabs	11.25	13.00	14.25
Copper sheets, base	27.75	27.75	27.75
Copper wire, mill, base	19.87½	19.87½	19.87½
Copper, drawn, round, base	26.25	26.25	26.25
Copper tubing, base	29.25	29.25	29.25
Brass sheets, high, base	23.25	23.25	23.25
Brass tubing, high, base	28.25	28.25	28.25
Brass rods, high, base	21.25	21.25	21.25
Brass wire, high, base	23.75	23.75	23.75

SHOP MATERIALS AND SUPPLIES

METALS—Continued

	New York	Cleveland	Chicago
Aluminum ingots, 99%.....	25.00*	24.30	24.30
Zinc sheets (casks).....	11.00	11.70	10.11
Solder (½ and ½).....	32.50	32.75	31@34
Babbitt metal, delivered in case lots, New York, cents per lb:			
Genuine, highest grade.....			62.00
Commercial genuine, intermediate grade.....			45.00
Anti-friction metal, general service.....			31.50
No. 4 babbitt.....			12.00

*Delivered.

NICKEL AND MONEL METAL—Price in cents per lb., base, f.o.b. Huntington, W. Va:

	Nickel	Monel Metal
Sheets, full finished.....	52.00	42.00
Sheets, cold rolled.....	60.00	50.00
Strip, cold rolled.....	55.00	45.00
Rods, hot rolled.....	45.00	35.00
Rods, cold rolled.....	53.00	40.00†
Tubing.....	75.00*	90.00
Angles, hot rolled.....	50.00	40.00
Plates.....	52.00	42.00

*Seamless. †Cold drawn.

OLD METALS—Dealers' purchasing prices in cents per pound, f.o.b. cars, depending on quantity offered for sale:

	New York	Cleveland	Chicago
Crucible copper.....	15.25 @15.50	13.50	13.00 @14.00
Copper, heavy, and wire..	14.00 @15.25	13.00	12.00 @13.00
Copper, light, and bottoms	12.50 @13.00	12.50	11.00 @12.00
Heavy lead.....	5.37½@ 5.62½	6.25	5.00 @ 5.50
Tea lead.....	3.75 @ 4.25	4.25	4.00 @ 4.50
Brass, heavy, yellow.....	8.50 @ 9.00	8.00	8.00 @ 8.50
Brass, heavy, red.....	.....	12.50	12.00 @12.50
Brass, light.....	7.00 @ 7.50	7.50	8.00 @ 8.50
No. 1 yellow rod turnings.	9.50 @10.00	9.00	10.00 @10.50
Zinc.....	3.25 @ 3.50	3.25	3.00 @ 3.25

TIN PLATES—Charcoal—Bright—Per box:

	New York	Cleveland	Chicago
"AAA" Grade:			
IC, 14x20.....	$12.10	$11.95	$11.50
"A" Grade:			
IC, 14x20.....	9.70	9.90	9.50
Coke Plates—Primes—Per box:			
100-lb., 14x20.....	6.45	6.10	7.00
Terne Plates—8-lb. Coating—Small lots—Per box:			
IC, 14x20.....	7.75@8.00	7.00	7.50

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.*	$0.10@0.13½	$0.16	$0.15
Cotton waste, colored, per lb.*	.09@ .13	.12	.12
Wiping cloths, washed white, per lb.†	.16	38.00 per M	.16
Sal soda, per lb.....	.02½	.02	.02
Roll sulphur, per lb.....	.02¾	.03½	.04
Linseed oil, raw, in 1 to 4 bbl. lots, per lb.....	.117	.11	.117
Cutting oil, about 25% lard, in 5 gal. cans, per gal.....	.75	.60	.65
Machine oil, medium-bodied (55 gal. steel bbl.) per gal..	.33	.36	.35
Belting — Present discounts from list in fair quantities (½ doz. rolls) for leather or rubber:			
Leather—List price, 24c. per lin. ft., per inch of width, for single ply:			
Medium grade.....	30–10%	30–10%	35%
Med. grade, heavy wgt...	30– 5%	30– 5%	30%
Rubber transmission, 6-in., 6 ply, $1.83 per lin.ft:			
First grade.....	50%	50–10%	50%
Second grade.....	60%	60– 5%	50–10%

*All waste in bale lots. †100-lb. bales.

Comparative Warehouse Prices

New York	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars.....	per lb..	$0.0325	$0.0325	$0.0325
Cold drawn shafting...	per lb..	.035	.035	.034
Brass rods.....	per lb..	.2125	.2125	.17
Solder (½ and ½).....	per lb..	.32	.325	.315
Cotton waste, white...	per lb..	.10@.13½	.10@.13½	.10@.13½
Disks, aluminum oxide mineral, cloth, No. 1, 6-in. dia.....	per 100.	3.60	3.60	3.10
Lard cutting oil.....	per gal.	.75	.55	.65
Machine oil.....	per gal.	.33	.33	.30
Belting, leather, medium.....	off list..	30–10%	30–10%	30–10%
Machine bolts, up to 1x30 in., full kegs...	off list..	50-10%*	50–10%*	50%*

*List prices as of April 1, 1927.

MISCELLANEOUS—Continued

	New York	Cleveland	Chicago
Abrasive materials — Standard grade, in sheets 9x11 in., No. 1, per ream of 480 sheets:			
Flint paper.....	$4.50	$4.29	$4.29
Emery cloth.....	22.93	20.97	20.97
Disks, aluminum oxide mineral, 6 in. dia., No. 1, per 100:			
Paper.....	2.64	2.04	2.04
Cloth.....	3.60	3.59	3.59
Fire clay, per 100 lb. bag.....	1.00	.75	.75
Coke, prompt furnace, per net ton...	Connellsville, 2.75@2.85		
Coke, prompt foundry, per net ton...	Connellsville, 3.75@4.50		
White lead, dry or in oil...	100 lb. kegs....	New York, 13.75	
Red lead, dry.....	100 lb. kegs....	New York, 13.75	
Red lead, in oil.....	100 lb. kegs....	New York, 15.25	

SHOP SUPPLIES

Discounts from new list dated Apr. 1, 1927, applying on immediate deliveries from warehouse stocks in New York and vicinity:

Machine bolts:	
Up to ¾-in. x 6-in., full kegs, list less.....	60%
Larger, up to 1 x 30-in., full kegs, list less.....	50–10%
Less than full kegs or case lots, add to list.....	10%
Fitting-up bolts: list less.....	45%
Lag screws:	
Up to ½-in. x 6-in., list less.....	60%
Larger, list less.....	50–10%
Less than full keg or case lots, add to list.....	10%
Rivets:	
Structural, round head, full kegs, net.....	$4.50
Structural, round head, broken kegs, net.....	6.00
Tank, ⅛-in. dia. and smaller, list less.....	60%
Nuts:	
Hot pressed, square or hexagonal, blank or tapped:	
Full kegs up to 1-in., incl., list less.....	60%
Larger, up to 3-in., list less.....	40–10%
Less than keg or case lots, add to list.....	10%
Washers:	
Wrought, full kegs, per 100 lb., list less.....	$4.00
Wrought, broken kegs, per 100 lb., list less.....	2.00
Turnbuckles:	
With stub ends, list less.....	20%
Without stub ends, list less.....	50%
Chain:	
Proof coil, base, per 100 lb., net.....	$7.10
Cast iron welding flux, per lb., net.....	.40
Brazing flux, per lb., net.....	.80

MACHINE REQUIREMENTS AND INDUSTRIAL CONSTRUCTION

Equipment Wanted

Mass., Boston—Hinds & Coon, 116 Pearl St.—belt machinery, 10 in. hand scarfer, Fortuna machine.

Mass., Boston—Schoolhouse Dept., City Hall—shapers, tool room lathes, etc., for mechanics arts high school, Belvidere St.

Mass., Westfield—Westfield Trade School, School Board—machinery and equipment for proposed addition to school. Estimated cost

Mich., Detroit — Bower Roller Bearing Co., 3040 Hart Ave.—one complete grinder and equipment.

Mich., Detroit—Detroit Butcher Supply Co., 1455 Gratiot Ave.—machinery and equipment for the manufacture of refrigerators, blocks, scales, etc., for proposed 2 story factory on Bellevue Ave. Estimated cost $50,000.

Ont., Niagara Falls—Lionite Abrasive Ltd.—eight electric furnaces for proposed 1 story, 85 x 360 ft. factory on Stanley St. Estimated cost $150,000.

Opportunities for Future Business

Calif., San Francisco—American Can Co., 230 Park Ave., New York, N. Y., will build addition to plant here.

Conn., Bridgeport—A. J. Pascone, awarded contract for a 1 and 2 story, 20 x 80 and 50 by 80 ft. repair and service garage at Rosedale and Oliver Sts. Estimated cost $40,000.

Conn., West Hartford (Hartford P. O.)—Capital Buick Co., Washington St., Hartford, awarded contract for a 1 story sales and service station on Raymond Rd. Estimated cost $45,000.

Ill., Chicago—Cameron Can Machine Co., 240 North Ashland Ave., awarded contract for a 1 story, 95 x 98 ft. factory at 1610-18 Walnut St. Estimated cost $30,500.

Ill., Chicago—Carlson Forging Co., 727 Fulton St., awarded contract for a 1 story, 86 x 200 ft. factory and shop at 1052-60 Kolmar Ave. Estimated cost $33,000.

Ill., Chicago—Graham, Anderson, Probst & White, 80 East Jackson Blvd., will receive bids until July 17 for a 2 story addition to factory for Edison Electric Appliance Co., Inc., South Menard and Taylor Sts.

Ill., Chicago—R. G. Lydy, 3 West Wacker Dr., awarded contract for a 2 story, 100 x 181 ft. garage at 212-21 West Lake St. Estimated cost $275,000.

Ill., Chicago—Sterling Mfg. Co., 1410 Wrightwood Ave., awarded contract for a 1 story, 25 x 250 ft. factory for the manufacture of radios at 1436 Wrightwood Ave. Estimated cost $30,000.

Ill., Rockford—G. D. Roper Corp., manufacturers of gas stoves, plans the construction of a 1 and 2 story, factory and office at Black Hawk Blvd. Estimated cost $750,000. F. D. Chase Inc., 720 North Michigan Blvd., Chicago, Archts.

Ind., Auburn—Auburn Automobile Co., had plans prepared for addition to plant. A. M. Strauss, Fort Wayne, Archt.

Ind., East Orange—G. B. Limbert & Co., J. D. Purdy, Pres., 556 Fulton St., Chicago, Ill., awarded contract for addition to factory. Estimated cost $50,000.

Ia., Davenport—Blackhawk Foundry & Machine Co., 323 South Clark St., awarded contract for a 1 story, 110 x 160 ft. addition to foundry on South Clarke St. Estimated cost $50,000.

Ia., Dubuque—J. H. Rhomberg is having plans prepared for a 1 story, 100 x 200 ft. garage, etc. Estimated cost $50,000. G. J. Krajewski, 730 Main St., archt.

Md., Baltimore—M. J. Barry, Lanvale and Charles Sts., will soon award contract for a 1 story, 50 x 200 and 16 x 100 ft. automotive service building at Lanvale and Morton Sts. F. Thomas, 726 East 33rd St., Archt. H. F. Doeleman, 516 North Charles St., Engr.

Md., Baltimore—Cuiffe-Cadillac Co., Mount Royal and Charles Sts., will soon award contract for a 3 story, 100 x 184 ft. garage and sales and service building at St. Paul and 24th Sts. H. F. Baldwin, 339 St. Paul St., and Kubitz & Koenig, Emerson Tower, Archts.

Mass., Ashland—Warren Telechron Co., plans a 2 story addition to factory. Fay, Spofford & Thorndike, 44 School St., Boston, Engrs.

Mass, Brookline—A. Snyder and M. Rudnick, 18 Tremont St., Boston, are receiving bids for a 3 story, 100 x 155 ft. garage and repair shop at 734 Commonwealth Ave. and St. Mary's St. Estimated cost $250,000. H. F. Bryantt & Son, 335 Washington St., Brookline, Archts.

Mass., Chicopee—A. G. Spaulding & Bros., Center St., awarded contract for the construction of a 1 story, 40 x 85 ft. forging building and 2 story, 30 x 100 ft. machine shop.

Mass., Framingham (Boston P. O.)—Noyes-Buick Sales Co., 857 Commonwealth Ave., Boston, plans the construction of a garage and repair shop at 100 Pearl St. Estimated cost $50,000. F. A. McShaffrey, 857 Commonwealth Ave., Archt.

Mass., Marlboro—Marlboro Wire Goods Co., Lincoln St., awarded contract for addition to factory. Estimated cost $50,000.

Mass., Needham (Boston P. O.)—Town, E. H. Allen, Chn. Bldg. Committee, is having plans prepared for the construction of a 3 story, 100 x 300 ft. school including manuel training and science shops, etc. Estimated cost $420,000. R. C. Sturgess, 120 Boylston St., Boston, Archt.

Mass., New Bedford — E. T. Caswell, 570 Pleasant St., will build a 2 story toy factory, including motor operating machinery, also new heating plant. Private plans.

Mass., North Adams—James Hunter Machine Co., 2 Main St., awarded contract for a 1 story, 75 x 155 ft. shop. Estimated cost $75,000. Noted June 27.

Mass., Springfield—Cadillac-LaSalle Co., M. J. Duryea, 563 State St., is having plans prepared for a 1 and 2 story repair shop and service building. Estimated cost $90,000. Argonaut Realty Corp., General Motors Bldg., Detroit, Mich., Archt.

Mass., Springfield—Norton Tire Stores, Inc., C. L. Norton, 50 Hillman St., is having plans prepared for the construction of a 1 story, 90 x 95 ft. service station at Westchester and State Sts. Estimated cost $45,000. R. M. Mowry, 25 Harrison Ave., Archt.

Mass., Watertown—J. W. Greer Co., 110 Windsor St., Cambridge, manufacturers of machinery, plans a 2 story, 80 x 500 ft. plant. Architect not selected.

Mass., Worcester—Heald Machine Co., P. Morgan, Pres., awarded contract for addition to factory on New Bond St. Estimated cost $40,000. Private plans.

Mich., Detroit—Detroit Steel Products Co., 2255 East Grand Blvd., is having plans prepared for the construction of first unit to steel sash factory, 1 story, 200 x 700 ft., on Mt. Elliott Ave. Estimated cost $400,000. Smith, Hinchman & Grylls, 800 Marquette Bldg., archt.

Miss., Jackson — Watkins-Watkins & Eager, awarded contract for a 2 story auto service station at Capitol and Robinson Sts. Estimated cost $100,000.

Mo., Richmond Heights—J. Sprague, 1107 Bellevue Ave., will build a 1 story, 100 x 170 ft. repair and service garage at Big Bend and Dale Ave. Estimated cost $50,000.

Mo., St. Louis—Terminal Railroad Association, 1800 Market St., awarded contract for a 1 story, 45 x 173 ft. shop and storage building at 301 South 18th St. Estimated cost $45,000.

N. H., Dover—F. E. Grimes, is receiving bids for a 1 story, 65 x 170 ft. repair and service garage. Estimated cost $40,000. J. E. Richardson, 56 Grove St., Archt.

N. J., Newark—Kent Garage Investment Corp., M. A. Kent, Pres., 350 Madison Ave., New York, awarded contract for a 20 story, 180 x 190 ft. garage at Warren and Washington Sts. Estimated cost $1,000,000.

N. Y., Astoria—J. Goldberg, 1255 Park Pl., Brooklyn, plans an 87 x 134 ft. garage at Goodrich St. and Astoria Ave. Estimated cost $40,000. Cohn Bros., 363 Stone Ave., Archts.

N. Y., Brooklyn—Royal Show Case Co., V. Benenuto, Pres., 648 Wythe Ave., will receive bids about Nov. 1 for a 1 story, 40 x 100 ft. factory at Ditmas Ave. and East 89th St. Estimated cost $40,000. M. Klein, 65 Court St., Archt. Noted May 24.

N. Y., Laurel Hill (mail Flushing)—Nichola Copper Co., Halle and Hobson Aves., plans a 3 story, 77 x 77 ft. addition to plant. Estimated cost $40,000. Leddy & Moore, 70 West 40th St., New York, Archts.

N. Y., Long Island City—H. Webb Realty Corp., H. Weprin, Pres., 145 West 27th St., New York, awarded contract for the construction of a 6 story garage at 2-8 Sylvan Pl. Estimated cost $100,000.

N. Y., New York—R. Bernson, 1306 Jerome Ave., will build a garage at 408 East 18th St. Estimated cost $80,000. Noted June 13.

N. Y., New York—Superior Fire Proof Door & Sash Co., D. Schafer, Pres., will build a 2 story, 100 x 200 ft. factory at Bates, Poplar and Barbour Sts. Estimated cost $150,000. H. Ginsberg, 205 West 42nd St., Archt. Noted July 4.

O., Cleveland—Cleveland Chain & Mfg. Co., L. D. Round, Stop 3, Bedford Line, awarded contract for a 1 story, 40 x 100 ft. addition to factory. Estimated cost $40,000. Noted June 20.

O., Cleveland—Ohio Piston Co., C. Birnbaum, Pres., 5337 St. Clair Ave., plans the construction of a factory. Estimated cost $40,000. Kalsch & Hoefler, 4500 Euclid Ave., Archts. Noted Jan. 31.

O., Youngstown—McKay Machine Co., Rayen and Foster Sts., plans to rebuild and enlarge factory for the manufacture of machinery for automobiles. Estimated cost $100,000. Private plans.

Okla., Tulsa—W. Philips, Philtower Bldg., awarded contract for a 5 story, 140 x 150 ft. shops, offices, etc., at 5th and Boston Sts. Estimated cost $300,000.

Pa., Allentown—Central Motorramp Garage, awarded contract for a 4 story, 100 x 122 ft. addition to garage at Law and Court Sts. Estimated cost $225,000.

Pa., New Castle — Blair Strip Steel Co. awarded contract for a 110 x 125 ft. plant to include cold rolling mill, etc. Estimated cost $100,000.

Pa., Philadelphia—Twenty-Second St. Realty Corp., c/o E. A. Stopper, 10 South 18th St., awarded contract for a 2 story, 64 x 133 and 30 x 64 ft. sales and service building at 248-54 North 22nd St. Estimated cost $175,000.

Wis., Milwaukee—Downing Box Co., 1702 3rd St., will soon award contract for a 1 story, 60 x 122 ft. factory. Eschweiler & Eschweiler, 210 Mason St., Archts.

Man., Winnipeg — Northwest Airways Ltd., plans the construction of an airport and plant. Estimated cost $250,000.

Ont., Chatham — Hayes Wheel & Forgings Ltd., 240 Raleigh Ave., awarded contract for the construction of a plant. Estimated cost $100,000.

Ont., Toronto—H. E. Given, 684 Yonge St., awarded contract for a 2 story garage, etc. Estimated cost $150,000.

Ont., Walkerville—Automotive Gaskets Ltd., manufacturers of gaskets and automobile accessories, plans the construction of a plant.

Que., Joliette—R. Gariepy, 29 St. James St., Montreal, is having plans prepared for the construction of a garage here. Estimated cost $200,000. J. Dufresne, lessee.

Que., Montreal—E. A. Doucet, 19 South St., Catharine St. E., is having plans prepared for a garage on Fabre St. Estimated cost $200,000.

Ave., Boston, Archt.

Que., Montreal—Stinson-Reeb Supply Co. Ltd., 230 Dorchester St., W., plans the construction of a factory, on Deserables St. Estimated cost $150,000.